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## LESSONS OF THE PARK PLACE DISASTER.

*By Edward Atkinson.*

I HAVE been requested by the editor of THE ENGINEERING MAGAZINE to submit such suggestions as may have been developed by my connection with factory construction, in order that the right method of avoiding a recurrence of such awful disasters as that which lately occurred in Park Place, New York, may be put before the public in the plainest and simplest terms. My own experience has been limited mainly to the construction of factories and of storehouses connected therewith. Reasoning by analogy many of the rules and practices which have been adopted in factory construction may be rightly applied to the construction of warehouses in cities, or to buildings of which a part or the whole may be used for purposes corresponding to those of a textile factory or machine shop.

There has been but one instance of the fall of a building within the experience of the mutual insurance company of which I am now president, except during or in consequence

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of a fire. This instance was in the case of the Pemberton mill in Lawrence, Mass.,and it occurred before I had any connection, even as a director, with the insurance company. The cause of the fall was directly traced to defective cast-iron columns, which had been made in horizontal moulds, causing the cores to float, as I am informed, from which the castings came out thin on one side and thick on the other. Fire occurred after the mill had fallen. The question arose whether or not the fall of the mill due to defective construction, constituted an alteration in the conditions of the risk such as to render the policies of insurance legally void. The case was not carried into court, but was compromised by the payment of a part of the amount of the insurance.

This question of the invalidation of insurance policies is one likely to be raised in the case of the building which fell in Park Place. That this building was overloaded, that it was not constructed to carry with safety the machinery which was placed in it, and that its fall, though perhaps initiated by some comparatively slight shock (which might have been an explosion of benzine), would not have occurred but for the overloading, will, I should think, not be doubted by experts who have read the accounts of the disaster and the evidence given at the coroner's inquest.

A building in which the only thing that could have exploded was, so far as is known, a small quantity of benzine vapor mixed with air, suddenly collapses into a complete wreck, overwhelming in its ruins its occupants, of whom sixty-three are killed. The breaking up of all parts of the structure is so thorough and their entanglement so great, that with all the force that can find room to work night and day the bodies cannot be recovered for more than a week. Surely this is not what would happen from a small explosion of benzine in a building intelligently constructed to support ponderous working machinery and heavy weights of merchandise. The fire which followed the fall can hardly be considered as anything but an incident ; it was truly an unfortunate incident as regards the destruction of the maimed bodies, perhaps, in a few cases, involving the loss of lives that could otherwise have been saved ; but the evidence at the inquest shows a strong probability that few, if any, could have been taken out alive in the absence of fire ; and the flames probably added very little to the destruction of property after such a complete collapse.

The evidence of an explosion in the building is, however, not conclusive. It is plain to me from the testimony that even if there

was a slight explosion it would not have caused the disaster, had the building been suitable for the use to which it was put. The evidence of the architect that the building had not been constructed to meet the strains of the heavy presses which had been placed upon the upper stories is conclusive.

Why should not a computation have been made of the breaking strength of the materials of which the floors were constructed, and also of the weight that was put upon them? An architect employed by the New York *Herald* to report upon the fall of the building is quoted, in that paper, as saying that in many cases it would be impossible to determine whether floors are overloaded or not. I feel certain that in this statement an intelligent architect has been misrepresented. It is easy enough, in the majority of cases, to come to a reasonable certainty on this point. The accompanying tables prepared by Mr. C. J. H. Woodbury, a civil engineer of distinguished attainments, and based upon careful tests, give the safe load and the limit of deflection of every shape and size of timber that is ordinarily used, together with the weights of most kinds of merchandise customarily placed on any floor, and their use will enable any person of ordinary capacity to determine whether or not a floor in almost any building constructed with timber beams and posts is safe or unsafe.

These tables are computed for beams one inch in width. The strength of beams of any other thickness will be directly as the thickness,—that is to say, for beams 2, 3, and 4 inches thick, 2 times, 3 times, 4 times the strength as given in the tables, and so on for any thickness when the beams are broad enough not to cripple. The tables, moreover, apply to distributed loads; but the first may also be used for floors designed to carry concentrated loads, by dividing the figure for distributed load by 2; as beams will carry twice the load when uniformly distributed along their length that they will sustain when the load is concentrated in the middle of their span. It should also be borne in mind that the weight of the floor itself must be included and considered as a part of the safe load that the floor will bear; that is to say, the weight that can be put upon the floor safely, is the computed safe load *less* the weight of the floor itself.

Table I is computed to afford a factor of safety of six, that is, for a load of only one-sixth what would break the beams down were they all perfectly sound and good. This factor of safety ought always to be allowed, to compensate for possibly unknown

and hidden weaknesses in the materials. This table is also computed for Southern pine, but may be made applicable to spruce by multiplying the tabulated figures for the strength of the different dimensions by $\frac{78}{100}$ or the decimal 0.78.

In computing the weights of floors allow 38 pounds for each cubic foot of spruce in the floor ; and for Southern pine 48 pounds.

Solid beams or heavy timbers should not be painted, varnished, oiled, filled, or encased in impervious concrete, air-proof plastering, or metal, for at least three years, else they are liable to dry rot.

TABLE I.

SAFE DISTRIBUTED LOADS UPON SOUTHERN PINE BEAMS ONE INCH IN WIDTH.

(If the load is concentrated at the centre of the span, the beams will sustain half the amount as given in the table.)

| Span Feet. | DEPTH OF BEAM IN INCHES. | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| | LOAD IN POUNDS PER FOOT OF SPAN. | | | | | | | | | | | | | | |
| 5 | 33 | 86 | 154 | 240 | 346 | 470 | 614 | 778 | 960 | ... | ... | .... | .... | .... | .... |
| 6 | 27 | 60 | 107 | 167 | 240 | 327 | 427 | 540 | 667 | 807 | .... | .... | .... | .... | .... |
| 7 | 20 | 44 | 78 | 122 | 176 | 240 | 314 | 397 | 490 | 593 | 705 | 828 | .... | .... | .... |
| 8 | 15 | 34 | 60 | 94 | 135 | 184 | 240 | 304 | 375 | 454 | 540 | 634 | 735 | .... | .... |
| 9 | | 27 | 47 | 74 | 107 | 145 | 190 | 240 | 296 | 359 | 427 | 501 | 581 | 667 | 759 |
| 10 | .... | 22 | 38 | 60 | 86 | 118 | 154 | 194 | 240 | 290 | 346 | 406 | 470 | 540 | 614 |
| 11 | .... | .... | 32 | 50 | 71 | 97 | 127 | 161 | 198 | 240 | 286 | 335 | 389 | 446 | 508 |
| 12 | .... | .... | 27 | 42 | 60 | 82 | 107 | 135 | 167 | 202 | 240 | 282 | 327 | 375 | 474 |
| 13 | ... | .... | ... | 36 | 51 | 70 | 90 | 115 | 142 | 172 | 205 | 240 | 278 | 320 | 364 |
| 14 | .... | .... | .... | 31 | 44 | 60 | 78 | 99 | 123 | 148 | 176 | 207 | 240 | 276 | 314 |
| 15 | .... | .... | .... | 27 | 38 | 52 | 68 | 86 | 107 | 129 | 154 | 180 | 209 | 240 | 273 |
| 16 | .... | .... | .... | .... | 34 | 46 | 60 | 76 | 94 | 113 | 135 | 158 | 184 | 211 | 240 |
| 17 | .... | .... | ... | .... | 30 | 41 | 53 | 67 | 83 | 101 | 120 | 140 | 163 | 187 | 217 |
| 18 | .... | .... | .... | .... | .... | 36 | 47 | 60 | 74 | 90 | 107 | 125 | 145 | 167 | 190 |
| 19 | .... | .... | ... | .... | .... | ... | 43 | 54 | 66 | 80 | 96 | 112 | 130 | 130 | 170 |
| 20 | .... | .... | .... | .... | .... | .... | 38 | 49 | 60 | 73 | 86 | 101 | 118 | 135 | 154 |
| 21 | .... | ... | .... | .... | .... | .... | .... | 44 | 54 | 56 | 78 | 92 | 107 | 122 | 139 |
| 22 | .... | .... | .... | .... | .... | ... | .... | .... | 50 | 60 | 71 | 84 | 97 | 112 | 127 |
| 23 | .... | .... | .... | .... | .... | .... | .... | ... | 45 | 55 | 65 | 77 | 89 | 102 | 116 |
| 24 | .... | .... | .. | ... | .... | .... | .... | .... | .... | 50 | 60 | 70 | 82 | 94 | 107 |
| 25 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 46 | 55 | 65 | 75 | 86 | 98 |

Table II, page 142, is applicable to floors for the support of working machinery. It may be made to apply to spruce, by multiplying the figures for strengths for the respective dimensions by $\frac{6}{10}$, or the decimal 0.6.

## WEIGHTS OF MERCHANDISE.

| MATERIAL. | MEASUREMENTS. | | WEIGHTS. | | |
|---|---|---|---|---|---|
| | Floor space. | Cubic feet. | Gross. | Per sq. foot. | Per cubic foot. |
| **Wool.** | | | | | |
| Bale East India | 3.0 | 12. | 340 | 113 | 28 |
| " Australia or Oregon | | | | | 15 |
| " South America | 7.0 | 34. | 1000 | 143 | 29 |
| Bag Wool | 5.0 | 30. | 200 | 40 | 7 |
| Stack of Scoured Wool | | | | | 5 |
| **Woolen Goods.** | | | | | |
| Case Flannels | 5.5 | 12.7 | 220 | 40 | 17 |
| " Flannels, heavy | 7.1 | 15.2 | 330 | 46 | 22 |
| " Dress goods | 5.5 | 22.0 | 460 | 84 | 21 |
| " Cassimeres | 10.5 | 28.0 | 550 | 52 | 20 |
| " Underwear | 7.3 | 21.0 | 350 | 48 | 16 |
| " Blankets | 10.3 | 35.0 | 450 | 44 | 13 |
| " Horse Blankets | 4.0 | 14.0 | 250 | 63 | 18 |
| **Cotton, etc.** | | | | | |
| Bale | 8.1 | 44.2 | 515 | 64 | 12 |
| " Compressed | 4.1 | 21.6 | 550 | 134 | 25 |
| " Dederick Compressed | 1.25 | 3.13 | 125 | 100 | 40 |
| " Jute | 2.4 | 9.9 | 300 | 125 | 30 |
| " Manila | 3.2 | 10.9 | 280 | 88 | 26 |
| " Hemp | 8.7 | 34.7 | 700 | 81 | 20 |
| **Cotton Goods.** | | | | | |
| Bale Unbleached Jeans | 4.0 | 12.5 | 300 | 72 | 24 |
| Piece Duck | 1.1 | 2.3 | 75 | 68 | 33 |
| Bale Brown Sheetings | 3.6 | 10.1 | 235 | 65 | 23 |
| Case Bleached Sheetings | 4.8 | 11.4 | 330 | 69 | 30 |
| Bale Print Cloth | 4.0 | 9.3 | 175 | 44 | 19 |
| Case Prints | 4.5 | 13.4 | 420 | 93 | 31 |
| Bale Tickings | 3.3 | 8.8 | 325 | 99 | 37 |
| Skeins Cotton Yarns | | | | | 11 |
| Burlaps | | | 130 | | 30 |
| Jute Bagging | 1.4 | 5.3 | 100 | 70 | 24 |
| **Paper.** | | | | | |
| Calendered Book | | | | | 50 |
| Super-Calendered Book | | | | | 69 |
| Newspaper | | | | | 38 |
| Writing | | | | | 64 |
| Wrapping | | | | | 10 |
| Manila | | | | | 37 |
| **Grain.** | | | | | |
| Wheat in Bags | 4.2 | 4.2 | 165 | 39 | 39 |
| " in Bulk, average | | | | | 41 |
| Barrels Flour on side | 4.1 | 5.4 | 218 | 53 | 40 |
| Corn in Bags | 3.6 | 3.6 | 112 | 31 | 31 |
| Cornmeal in Barrels | 3.7 | 5.9 | 218 | 59 | 37 |
| Oats in Bags | 3.3 | 3 6 | 96 | 29 | 27 |
| Bale of Hay | 5.0 | 20.0 | 284 | 57 | 14 |
| Hay, Dederick Compressed | 1.75 | 5.25 | 125 | 72 | 24 |
| **Dye Stuffs, etc.** | | | | | |
| Hogshead Bleaching Powder | 11.8 | 39.2 | 1200 | 102 | 31 |
| Box Indigo | 3.0 | 9.0 | 385 | 128 | 43 |
| " Sumac | 1.6 | 4.1 | 160 | 100 | 39 |
| Caustic Soda in iron drum | 4.3 | 6.8 | 600 | 140 | 88 |
| Barrel Starch | 3.0 | 10.5 | 250 | 83 | 23 |
| " Pearl Alum | 3.0 | 10.5 | 350 | 117 | 33 |
| Barrel Lime | 3.6 | 4.5 | 225 | 63 | 50 |
| " Cement, American | 3.8 | 5.5 | 325 | 86 | 59 |
| " " English | 3.8 | 5.5 | 400 | 105 | 73 |
| " Plaster | 3.7 | 6.1 | 325 | 88 | 53 |
| " Lard Oil | 4.3 | 12.3 | 422 | 98 | 34 |
| Rope | | | | | 42 |
| Box Tin | 2.7 | 0.5 | 139 | 99 | 278 |
| " Glass | | | | | 60 |
| Crate Crockery | 9 9 | 39.6 | 1600 | 162 | 40 |
| Cask Crockery | 13.4 | 42 5 | 600 | 52 | 14 |
| Bale Leather | 7.3 | 12.2 | 190 | 26 | 16 |
| " Raw Hides | 6.0 | 30.0 | 400 | 67 | 13 |
| " " Compressed | 6.0 | 30.0 | 700 | 117 | 23 |
| Pile Sole Leather | | | | | 17 |
| Barrel Granulated Sugar | 3.0 | 7.5 | 317 | 106 | 42 |
| " Brown Sugar | 3.0 | 7.5 | 340 | 113 | 45 |

TABLE II.

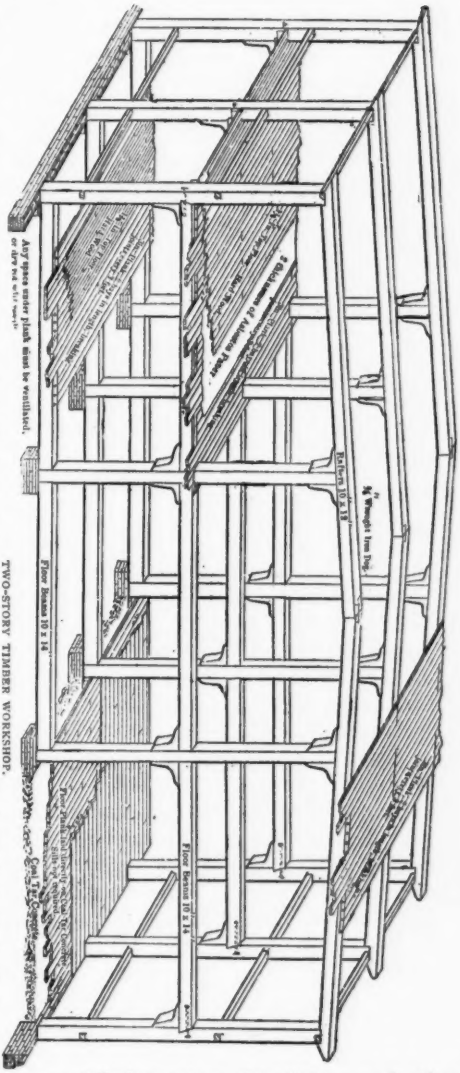
DISTRIBUTED LOADS UPON SOUTHERN PINE BEAMS SUFFICIENT TO PRODUCE STANDARD LIMIT OF DEFLECTION.

| Span Feet. | DEPTH OF BEAM IN INCHES. | | | | | | | | | | | | | | | Deflection inches. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | |
| | LOAD IN POUNDS PER FOOT OF SPAN. | | | | | | | | | | | | | | | |
| 5 | 3 | 10 | 23 | 44 | 77 | 122 | 182 | 259 | ... | .... | .... | .... | .... | .... | .... | .0300 |
| 6 | 2 | 7 | 16 | 31 | 53 | 85 | 126 | 180 | 247 | .... | .... | .... | .... | .... | .... | .0432 |
| 7 | .. | 5 | 12 | 23 | 39 | 62 | 93 | 132 | 181 | 241 | .... | ... | .... | .... | .... | .0588 |
| 8 | .. | 4 | 9 | 17 | 30 | 48 | 71 | 101 | 139 | 185 | 240 | 305 | .... | .. | .... | .0768 |
| 9 | .. | .. | 7 | 14 | 24 | 38 | 56 | 80 | 110 | 146 | 190 | 241 | 301 | .... | ... | .0972 |
| 10 | .. | .. | 6 | 11 | 19 | 30 | 46 | 65 | 89 | 118 | 154 | 195 | 244 | 300 | .. | .1200 |
| 11 | .. | .. | .... | 9 | 16 | 25 | 38 | 54 | 73 | 98 | 127 | 161 | 201 | 248 | 301 | .1452 |
| 12 | .. | .. | .... | .... | 13 | 21 | 32 | 45 | 62 | 82 | 107 | 136 | 169 | 208 | 253 | .1728 |
| 13 | .. | .. | .... | .... | 11 | 18 | 27 | 38 | 53 | 70 | 91 | 116 | 144 | 178 | 215 | .2028 |
| 14 | .. | .. | .... | .... | ... | 16 | 23 | 33 | 45 | 60 | 78 | 100 | 124 | 153 | 186 | .2352 |
| 15 | . | .. | ... | .... | .... | 14 | 20 | 29 | 40 | 53 | 68 | 87 | 108 | 133 | 162 | .2700 |
| 16 | .. | .. | .... | .... | ... | .... | 18 | 25 | 35 | 46 | 60 | 76 | 95 | 117 | 147 | .3072 |
| 17 | .. | .. | ... | .... | .... | .... | 16 | 22 | 31 | 41 | 53 | 68 | 84 | 104 | 126 | .3468 |
| 18 | .. | .. | .... | .... | .... | .... | .. | 20 | 27 | 37 | 47 | 60 | 75 | 93 | 112 | .3888 |
| 19 | .. | .. | .... | . .. | .... | ... | .... | 18 | 25 | 33 | 43 | 54 | 68 | 83 | 101 | .4332 |
| 20 | .. | .. | .... | ... | ... | ... | .... | .... | 22 | 30 | 38 | 49 | 61 | 75 | 91 | .4800 |
| 21 | .. | . | .... | .... | .... | ... | .... | .... | 20 | 27 | 35 | 44 | 55 | 68 | 83 | .5292 |
| 22 | .. | .. | .... | .... | .... | .... | .... | .. | .... | 24 | 32 | 40 | 50 | 62 | 75 | .5808 |
| 23 | .. | .. | .... | .... | .... | .... | .... | .... | .... | 22 | 29 | 37 | 46 | 57 | 69 | .6348 |
| 24 | .. | .. | .... | .... | .... | .... | ... | ... | ... | .... | 27 | 34 | 42 | 52 | 63 | .6912 |
| 25 | .. | .. | .... | .... | .... | ... | .... | ... | ... | ..... | 25 | 31 | 39 | 48 | 58 | .7500 |

Weights of machinery are always obtainable from the manufacturers of it, and are quite generally named in their catalogues. Weights of merchandise, in original packages, not included in the table, can be averaged by weighing a few packages; and although the table of weights is very convenient, its absence would not prevent any intelligent merchant or manufacturer, with a little painstaking, from arriving at the weight of material on any floor of a building occupied by him. Besides the facilities afforded by these tables for determining whether buildings with timber posts and beams are not loaded beyond the point of safety, there is expert aid to be had in the inspection of buildings no matter of what they may be constructed, and the results of such inspection and computation need not fail to give the safe load. The owner or occu-

pant should see that this load is not exceeded; but as owners and occupants are known to be often careless and neglectful of both public and private duties when consequences of neglect do not fall upon them personally, something should be done to make them careful.

An effective measure for preventing the recurrence of disasters like the one under consideration, might be a legal decision of the highest court that such conditions as those under which it occurred render void the obligation of the insurance companies to pay indemnity. This would bring the responsibility to the only point where the true remedy can be applied; to wit, upon the owners or occupants of the property. Building acts and police regulations,—public inspectors of buildings and other authorities, can only deal with the cruder or more obvious cases




TWO-STORY TIMBER WORKSHOP.

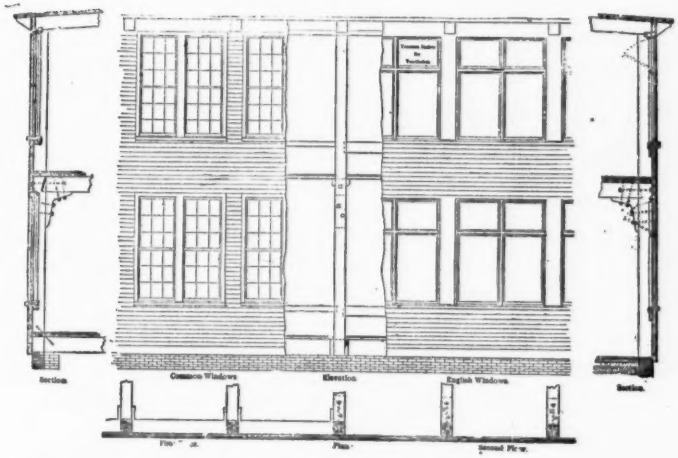
of danger and loss, either from the falling of buildings or from fire. They palliate, but do not remove the danger itself.

There is no reason why the owners or tenants of any city building may not be made justly liable for manslaughter in the event of the death of any person, due to an overloaded floor; and there is no reason why owners and tenants may not be held liable in exemplary damages for injuries to person or property which occur under conditions corresponding to those in Park Place.

A statute of the kind might not remove the danger directly, but such a statute would lead at once to the organization of insurance companies to indemnify the owner or the tenant for any verdict against them under such conditions. These insurance companies would at once establish a system of inspection for the purpose of protecting themselves against loss, and *that* inspection would be effective. The refusal of a reputable insurance company to insure a building occupied in the manner in which the Park Place building appears to have been occupied, would, of course, prevent any person from leasing or occupying buildings in a dangerous manner.

Another method of meeting this hazard may be found in the suggestion that a safe building may be put up at less cost than the ordinary or common examples of combustible architecture and bad construction with which most of our cities are infested. In dealing with this subject I shall present certain suggestions which have, as yet, only come in part into practice, even in factory construction. The rules which have been adopted in factory construction are substantially as follows: Cast-iron is to be almost wholly avoided both for posts or girders unless fully protected against damage by heat. For a long time heavy columns of cast-iron held their place against timber, but they are now seldom employed. Square posts of timber of such size as to be wholly free from the danger of being broken by any load that can be put upon them are used. They are customarily of large size, not only to support the weight, but in order that if fire occurs they may burn slowly and may last longer than the floor above, or as long.

The heavy timbers of the floors are also of such size as to be absolutely safe against any breaking strain that is liable to be put upon them, not only in order to meet the conditions of the load, but also to be free from injurious deflection which may throw shafting out of line, and in order that they may burn slowly. The ends of all timbers which rest upon walls are so shaped and disposed that



DETAILS OF TWO-STORY TIMBER WORKSHOP.

in case of dislodgment from fire or any other cause they may roll out from their bearings without straining the wall.

On the other hand city warehouses which I have inspected during the progress of their construction, and which were wholly within the requirements of the Building Act of the City of Boston, have been put up in such a way that the breaking of a single cast-iron girder, the giving way of a single iron post, or the breaking of a single transverse timber resting upon a front wall, would destroy the whole building, throwing the front wall into the street.

In one case where I foresaw the danger of such construction and made a futile attempt to have a better construction substituted for it, when a fire did occur, it was accompanied with immense destruction of property and the loss of several lives. In a very short time after taking fire the building fell across the street on which it fronted.

This leads directly to the engineering problem. In order to put this problem in the plainest way I will refer to plans and suggestions which were made by myself in 1880 for the construction of large factory buildings in such a way that *the mill should hold up the walls, rather than that the walls should support the mill.* My attention was called to this necessity in dealing with high and narrow factory buildings of a former type which were subjected to dangerous vibration, although not overloaded. These instances of dan-

gerous vibration have occurred from the synchronous motion of machinery, especially of looms; also under the effect of the rythmic fall of water over a dam close to the mill.

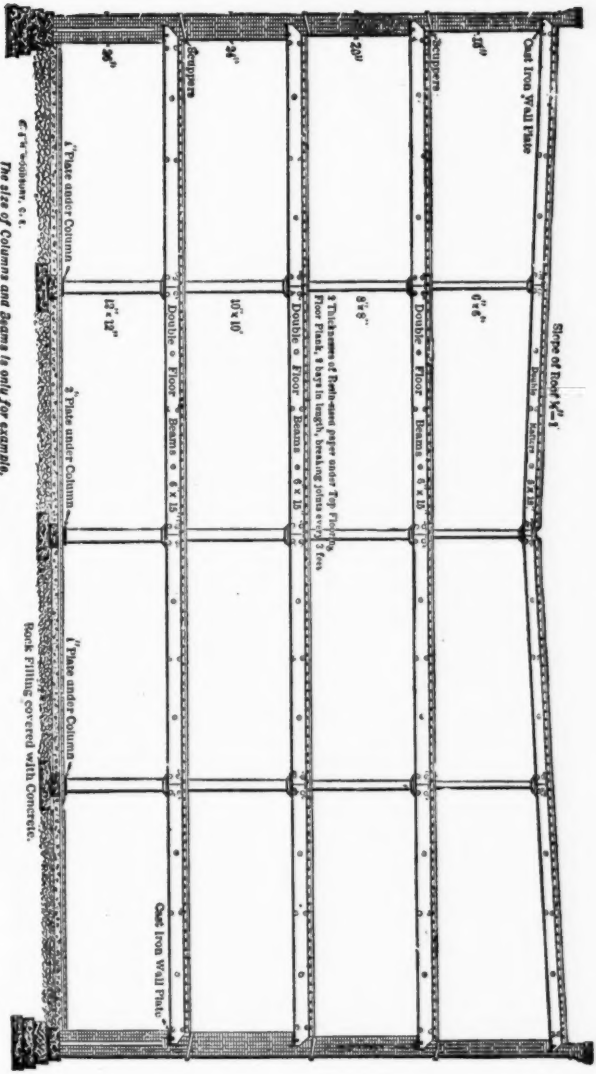
The danger from the operation of the machinery has sometimes been met by working a part of the looms at a different rate of speed from the rest, but this is so much lost time on the product of the loom.

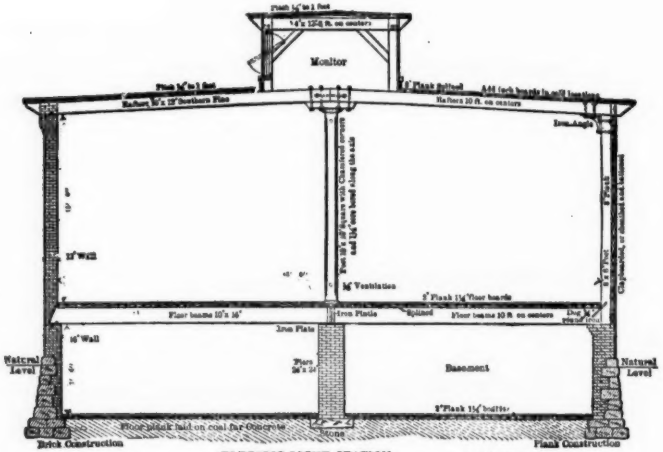
The first suggestion to meet this difficulty consisted in running up a line of vertical timbers next the wall between the floor beams, then inserting hackmatack knees like those that are made use of in the construction of vessels, bolted to the floor timbers and to the end posts or vertical timbers.

This device led to the consideration of a method of construction which could be readily adopted in city warehouses, and which has been already adopted in many western cities in the construction of high buildings that are, in fact, steel towers covered on the outside with a weather guard, or what may perhaps be considered a window frame, attached to the main structure by which it is wholly supported. This method may be applied to less costly buildings. It is perfectly easy to conceive of and to plan a factory or warehouse of which the framework may be erected, the floors laid, the roof put on and covered, and the building completely finished ready for placing the machinery therein, even deferring the consideration of what the walls should consist of until the structure has been otherwise finished.

This structure may consist of heavy timbers, both vertical and transverse, set eight to ten feet apart on spans of from twenty to twenty-five feet; the floor being braced at every point with wooden or iron knees; plank floors grooved and splined, the top floor laid over mortar or resin-sized paper; and each post (both the outer posts and those within) resting on its own separate pier. If iron or steel are adopted the framework may be set up complete and finished, and then covered in by vertical weather-guards and window frames, constituting the walls; this is the common practice-equally available when timber is used in place of metal.

These specifications for the framework of a heavy building, except as to the walls, are consistent with what is already known as "mill construction," or what is sometimes called "slow-burning construction" This method has once or twice been brought into disrepute because of the very quick destruction of a building said to have been put up according to the rules of the mill engineers.


Cast Iron Wall Plate
Skylights
Slope of Roof ¼" to 1'
Double Floor Beams 6 x 15
Skylights
Double Floor Beams 6 x 15
Double Floor Beams 6 x 15
Double Floor Beams 6 x 15
Double Floor Beams 6 x 15
Skylights
Double Floor Beams 6 x 15
Cast Iron Wall Plate
Rock Filling covered with Concrete.
Plate under Column
Plate under Column
Plate under Column




ELECTRIC-LIGHT STATION. C. I. H. Woodbury, F

It has been unfortunately true in several instances that architects who are not conversant with all the rules of safety prescribed by the mill engineers have adopted the heavy timbers set wide apart and the thick plank floors covered in by a solid and suitable roof; but they have then converted these primary elements of slow combustion into very quickly combustible buildings, first, by connecting floor with floor by open stairways or stairways sheathed with wood; second, by sheathing the walls of the lower stories and sometimes the whole building with wood; third, by setting up partitions containing many cords of light wood; and lastly, making the most fatal mistake of all in finishing the woodwork with the ordinary varnish, over which a fire runs with the rapidity of a race-horse.

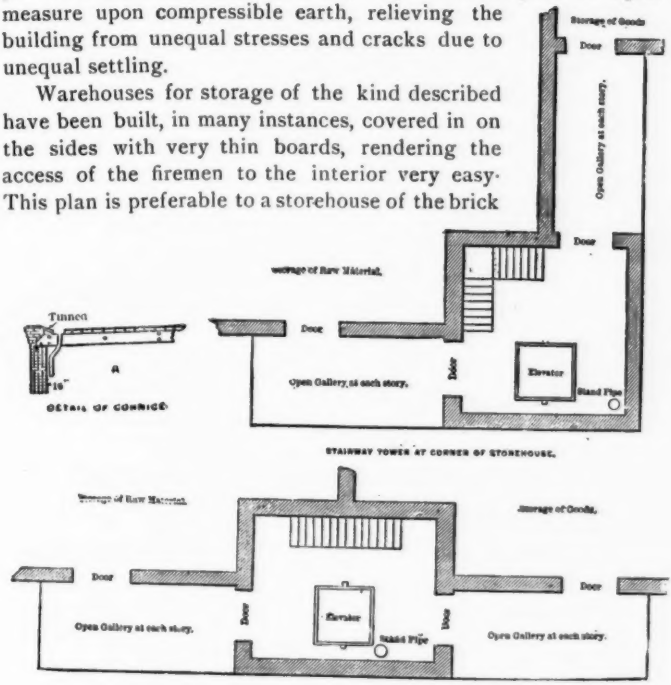
I have witnessed this conversion of the primary elements of a slow-burning building into one subject to very quick destruction in my own city. It would be well for architects to consult mill engineers before being misled into any partial application of the slow-burning methods.

I have known of two instances of otherwise well-constructed buildings surmounted by iron roofs resting upon iron trusses; these roofs and trusses were so expanded and twisted by moderate heat as to throw the walls of the buildings down before the fire had assumed an otherwise destructive headway within them. It has also long been the practice in factory construction to protect beams and ceil-

ings over extra-hazardous work either with plastering laid on wire lathing, or laid solid against timber or plank upon dovetailed or button lath of wood. Since the introduction of plaster board this material is being used for the same purpose, skimmed with a coat of King's Windsor Cement, or of adamant plaster.

There would be great advantages in this method of construction, independent of those of safety, especially in the construction of factories. In the factory, as commonly constructed, the heavy wall requires a very heavy foundation. It is subject to shrinkage and to settlement at a different rate from the shrinkage and the settlement of the timbers and the posts within. But a structure in which every support (both outer and inner lines) should rest upon piers of which the foundations should be so proportioned to the load which they may be called upon to sustain that all shall be subject to the same intensity of load, may therefore yield in equal measure upon compressible earth, relieving the building from unequal stresses and cracks due to unequal settling.

Warehouses for storage of the kind described have been built, in many instances, covered in on the sides with very thin boards, rendering the access of the firemen to the interior very easy. This plan is preferable to a storehouse of the brick




STANDARD STOREHOUSE CONSTRUCTION.

oven style, fitted with iron roof and doors, in which the conditions are such that the contents are very greatly damaged or totally destroyed when a fire occurs in them from any internal cause.

The piers on which these structures rest are sometimes made by digging a hole for each post with a scoop, putting down a lime-cask at the bottom—a second cask projecting above the ground—filling both to a level above the surface with good cement and broken stone, then tamping well around the outside of the casks. This makes a very inexpensive and a very firm support for the posts of a warehouse in a mill yard.

But beyond all considerations of safe construction, judicious legislation and proper public inspection, the lesson which this awful disaster enjoins with peculiar emphasis, is the one that every individual must look to himself for protection in such cases. No man need expect to escape the natural consequences if he continues, day by day, and week by week, to occupy a building which gives unmistakable evidence of being unsafe; and obviously, where the evidence is of a doubtful character, it should be brought promptly to the attention of a competent inspector, public or private, to the end that steps may be taken to avoid disaster. As Herbert Spencer has so aptly written: "No apparatus of senators, judges and police can compensate for the want of an internal, governing sentiment. No administrative sleight-of-hand can save us from ourselves."

# AN AMERICAN VIEW OF BRITISH FEDERATION.

*By Andrew Carnegie.*

WE have to consider whether Britain and her colonies would make good bargains by banding together against the outside world, and giving to each other more favorable terms than to outsiders. Reduced to this, it becomes simply a matter of figures. Britain exports about 250 millions sterling of her products yearly. Of these, the English-speaking self-governing colonies take 31 millions, or one-eighth; India takes about the same amount; all the other British possessions 20 millions sterling; in all, about 82 millions, leaving fully double that amount taken by other countries. It is proposed to discriminate against the customers who consume 166 millions sterling in favor of those who consume half that amount. With British imports it is just the same, for in 1889 imports and exports to colonies, etc., were only 187 millions out of a total of 554 millions sterling—one-third to the dependencies against two-thirds to the foreigners.

The important question is, What response would the nations of the world make to a declaration of industrial war against them? Had Britain and her colonies remained a compact free-trade Empire, like the forty-four States of the Republic, which furnish the world with the best proof of the blessings of free trade, other nations would have no right to object. It is quite a different matter, however, if, when their trade has been established and business built upon the other basis, change and disaster should now be visited upon them. A change in the policy of Britain towards other nations, I submit must now be followed by a change of their policy towards Britain. Discrimination must produce discrimination. The Republic of the United States, for instance, is Britain's greatest customer, taking more of British products than all the English-speaking colonies combined, and more and more every year, while the trade with the colonies is, at best, stationary, notwithstanding their increase of population. It has slightly declined during the past five years. What the Republic would do if she were discriminated against needs no guess, for she has already lodged in the President power to go so far as to prohibit entirely the products of any country that does.

Britain is called upon to justify her discrimination against American cattle, for instance, and nothing is surer than that the American people will have to be entirely satisfied that there is good cause for it, or the President will be forced by public sentiment to exercise this power, conservative, patient, and most peace-loving though President Harrison be. There would not be two parties upon this issue.

How about Germany? She takes from Britain every year products to the amount of about eighteen millions sterling, twice that taken by the whole of British North America, and not far from that taken by the whole of Australasia (twenty-two millions sterling). She sends Britain about three millions sterling per year of flour and cereals, of butter and eggs one million and a half sterling, of timber one million and a half sterling. What is to be the answer of the young irrepressible Emperor, if the products of his country are discriminated against in favor of the food products and timber of Canada and Australia? Italy, again takes about as much of British products as the whole of British North America, seven millions sterling, and she finds here each year a market to the extent of three millions sterling for her hemp, fruits, etc. The Argentine Republic takes ten to eleven millions sterling per annum from Britain; the whole of British North America only eight millions sterling. What is to be the return shot fired by her if her mutton, wool, and grain, which she sends here are to be discriminated against? But why continue the list? It is the same story everywhere.

Britain has the foreign trade of all her colonies almost exclusively already, except that of Canada, of which she has nearly one-half, the United States possessing rather more. All the other colonies deal with foreign nations only to the extent of five to ten per cent. for articles which Britain does not produce. The parent-land, therefore, has nothing to gain by any change in fiscal relations between herself and the colonies; her colonial trade could not be increased thereby. Why, then, should she jeopardize the control of the markets of the world to the extent of two-thirds of her total exports for nothing? This wondrous little island is dependent upon the world for two-thirds of its food supply; equally dependent upon the markets of the world for the sale of its products. There never was so great a people so artificially maintained. What the race has accomplished here under these conditions dwarfs the triumphs of all other races; it is marvellous, and if it were not before our eyes, it would be held impossible that a nation so placed could yet have led the

world. One asks instinctively what such a breed of men will do when controlling continents possessed of unbounded supplies of agricultural and mineral resources combined ; but that she being so placed, should be counselled by a body of able men to inaugurate an industrial war against the world seems something not to be accounted for by any process of reason. Russia, the Argentine or the Brazilian republics, with their ports blockaded for ten years, would suffer only more or less inconvenience. The United States would emerge from such an embargo stronger and more independent of the world than before. Close the ports of this island for a year, and her people would suffer for food. Britain's house is a whole Crystal Palace—she of all nations should be the last to begin stone-throwing.

From something in the national character, but much more in the part she has had to play in the world, Britain has excited the envy, jealousy, and ill-will of some of the most powerful nations ; but I do not believe that my native land has an enemy so bitter as to wish her to plunge into an industrial war which would be so cruelly fatal to her, for even the worst foe must feel that the human race owes an incalculable debt to Britain. It would be a different matter if the imposition of protective duties were proposed bearing equally upon the products of all other countries, for this is a matter for each nation to settle for itself, and other nations could take no offense if Britain decided to reimpose such duties. This would be no declaration of industrial war against other nations, but only a matter of home policy. There is no vital objection to this being tried ; although I am as certain that free trade is Britain's only policy as I am a thorough disciple of John Stuart Mill, and I am pleased to add, of his worthy successor, Professor Marshall, in believing that the countries which have the necessary resources within themselves, do well to encourage the starting of industries by protecting them for a time against the competition of those firmly rooted in other lands, always, however, with the view of ultimately obtaining a surer and cheaper source of supply within themselves.

Canada finds a market for more of her products in the neighboring Republic than in the parent-land. She also finds it to her advantage to purchase more from the former than from the latter. During the winter months she is indebted to the courtesy of the Republic for regular communication with the outside world ; her steamships land at Portland in Maine, and her traffic in bond, and her people, travel through American territory to reach Quebec or

Montreal. Her boasted east and west railway system would scarcely pay expenses; it certainly would yield no returns except that the Republic generously permits it to connect with American railways and compete with them upon equal terms for the traffic to and from Chicago and the great West to Boston, New York, and the East. The Canadian Pacific traverses the entire width of the State of Maine. All the ships of Canada receive rights in American ports which are denied to American vessels in Canadian ports. Any day the Republic thinks proper to resent the acts of her saucy little neighbor, which have recently been annoying, she can practically "bottle-up" Canada without giving any cause of complaint from an international point of view. She has simply to withhold privileges now generously granted. It need not be feared that so strong and forbearing a nation will act tyrannously to one so completely in her power. The Republic has always been the kindest and most neighborly of neighbors to all her less powerful sisters; *but the power is there*, and this being so, I should like to ask our "United Empire Trade League" friends what answer Canada would likely make to their proposition to discriminate in favor of Britain as against the Republic.

It will save much disappointment if the people at home can be made to understand and believe that the following truly represents the sentiments of ninety-nine out of every hundred native-born Canadians and Australians. I quote the words of the Premier of the important province of Quebec, Mr. Mercier, who, being asked whether he was opposed to Federation, replied:

> Yes, I am. I regard that policy as treason to Canada. Imperial federation means that Canada must join Britain in her wars throughout the world, and must weigh the interest of the whole Empire before looking to her own. A tie that would thus subject Canada completely to European dominion would be a most unnatural one, and there are not fifty men in the province of Quebec who are favorable to so unpatriotic a policy. The time has, in fact, come to consider in a very peaceful yet very serious way the right of European Powers to govern people living on the continent of America, whose interests and general tendencies, commercial or other, are in certain respects opposed to those of the people of Europe. Accordingly, instead of being disposed to strengthen the ties at present existing between Britain and Canada, we are, in fact, looking forward with some anxiety to the time when we shall ask for our independence. We shall request with all due respect to Great Britain, and without any ill feeling towards her people, just as a young man of full age, on leaving his father's home, may sometimes do it with reluctance, but with the proud feeling that he, too, is called upon to take a free and independent share in life. What I say about the province of Quebec, may, I believe, be said of the inhabitants of all the other provinces.

Sir John Macdonald asserted the independence of Canada to the fullest extent when he recently commanded Lord Salisbury to tear up a treaty which had been agreed upon by Sir Julian Pauncefote and Secretary Blaine, with Lord Salisbury's cordial approval, which the British Government had presumed to make without consulting Canada. The recent protest of Newfoundland is another case in point. The public is informed that the difficulty has been compromised, but the compromise has necessarily been all on one side. The form of arbitration with France is to be adhered to; but after this has been duly performed Newfoundland's demands will be complied with. There was no other course open to Britain. She cannot govern her colonies; for they are full-grown and almost of age and now dictate to her. They must be provided with homes of their own speedily if the filial tie is to be preserved.

It is of the utmost importance that the people of Britain should promptly realize her true relation to her colonies, which is just this: she is the mother-land, and no nation has ever been blessed with a family so numerous, enterprising, and creditable. The only part open to her is to play the mother, and as her children grow beyond the need of her fostering care, to endeavor to inculcate in them the ambition to go forth and manage for themselves. She should doubt the blood in any weakling content to remain under her protection when the age of manhood comes. True, few departures from the old home are unaccompanied by tears, but, after all, tears of affection, of joy, in the happiness of the child who starts in life for himself. There are only two modes that can be pursued: either the colonies shall leave the parent nest with the parent's blessing, carrying in their hearts undying love and reverence for her to whom they owe all, or the parting shall be made under conditions which must necessarily bring both parent and child life-long bitterness and life-long sorrow. The American boy is for ever to be in youth the hater of the old home, for in his early years he is fed with stories of the Revolution; of the struggles and sufferings of Washington and his patriot army; of the desire of his native land for independence, and of the mistaken efforts of Britain to hold it in subjection.

This early impression of Britain as the oppressor of his country is not easily removed. It is a thousand pities that the majority of our race is to learn first that the parent-land was its country's only foe. Britain can choose whether Australia and Canada and her other colonies, as they grow to maturity, can set up for themselves

with every feeling of filial devotion towards her, or whether every child born in these lands is to be born to regard Britain as the cruel oppressor of his country. There is no other alternative, and I beseech our friends of the Imperial Federation to pause ere they involve their country and her children in the disappointment and humiliation which must come, if a serious effort be made to check the development and independent existence of the colonies, for independence they must and will seek, and obtain, even by force if necessary.

Even if the various parts of the Empire could be federated under one sovereign—of which there is as little likelihood as that the Republic could be induced to enter—and thus the whole aim of the "Federation League" be accomplished, what then? Eleven millions of people will have been confederated with her—only this and nothing more—and Britain then would only be first in the smaller division of the race. It would not be such a prodigious gain for her after all. We should have "Hamlet" with Hamlet left out. Few persons have a correct knowledge of the numbers and increase of the various parts of our race. During the past ten years the United States added to its numbers more than the total present number of English-speaking people in all other parts of the world, outside of the United Kingdom. Her increase was nearly 12,500,000. The increase of Britain and all her English-speaking colonies was not one-half as great—about 5,250,000. Britain added slightly more than 3,000,000; Canada only 750,000; New South Wales (last eight years) only 471,000; Victoria (last nine years) 710,984 only, all other colonies only trifling numbers. Thus, if we place the Republic in one scale, and all the other parts of the race in the other, the yearly increase in the first scale would more than double that in the second. Even if the United States' increase is to be much less than it has been hitherto, yet the child is born who will see more than 400,000,000 under her sway. No possible increase of the race can be looked for in all the world combined comparable to this. Green truly says that its "future home is to be found along the banks of the Hudson and the Mississippi." Why should the parent-land then be counselled by the Imperial League to endeavor to form closer ties with her other children than with her eldest born, who must dwarf all the rest of the family combined? What kind of federation is that which leaves the Republic out? There is no obstacle to forming any tie with the Republic that can possibly be formed with the Commonwealth

of Australia or the Dominion of Canada, for, just as soon as these are asked to forego their inborn desire for independence similar to that of the United States, their answer will settle the question, if indeed the League ever requires to go so far as to ask for Imperial Federation and be refused. It should not be necessary for them to place the parent-land in a position so humiliating, for that their idea is impracticable can be learned in every quarter without exposing themselves to the inevitable and wholly unnecessary rebuff.

The great aim of the Federationist should be to draw together the masses of all English-speaking countries, and to make them feel that they are really members of the same undivided race, and share its triumphs; that all English-speaking men are brothers who should rejoice in each other's prosperity, and be proud of each other's achievements. The little faults or shortcomings of the other members should be overlooked, and all should dwell upon what is best in each, for, as members of the same race, what disgraces one necessarily reflects upon the entire family. Impossible "Imperial Federation" and "Empire Trade League" should give place to "Race Alliance," and so embrace all in one common bond, the only test being:

> If Shakespeare's tongue be spoken there,
> And songs of Burns be in the air.

Pursuance of this policy during our generation will do much to lay the foundation for a true federation of the whole race, as far as it is possible to combine sovereign powers, and how far that is possible is for future generations, not for this, to learn. That it is possible to a degree we of to-day already see. Once earnestly kept in view, and labored for, and lower aims excluded, it is probable that things now deemed impossible dreams may prove easy of getting. Indeed, the "Parliament of man" itself is only a question of time in the mind of the evolutionist who sees no bounds to the advance of man in the line of brotherhood. If we may not look into the future and tell what germ is to grow, we can at least do our duty in the present, and cultivate the soil and plant the germ which *ought* to grow among the members of the same race, leaving to posterity the duty of nurturing the precious seed, and, we trust, the fruition of our hopes.

The parent-land should be urged to encourage her colonies, as an able mother encourages her sons, to go forth at maturity and play the part of men—loving and reverencing her, but independent. The idea of federation among colonies should also be encour-

aged ; for no greater calamity could happen than that the various English-speaking communities should be divided into small nations, jealous of each other. The sad condition of Europe to-day, an armed camp contrasted with the United States, which is ere long to contain an English-speaking population as great as the whole of Europe, without any necessity for a standing army, should be continually in mind and proclaimed. The Australian colonies do not require the lesson. These are wise and will federate, and as one irresistible power keep the peace and rule that quarter of the globe without armies, for they, like the Republic, can have no foe ; but the union of England and Scotland should be held up to Canada and the United States. I should not like to think that I ever had said or ever should say a word that would tend to perpetuate upon the American continent two divisions of the race, or to feel that I had not exerted myself to produce union. The mother-land can do much by reminding Canada of her own union with Scotland, and the happy results which flow from it. The present unfortunate division of the race in America, so fraught with danger, is Britain's work ; the duty upon her to correct the evil is imperative. Nor is she unequal to the task, for she has done things that other nations cannot parallel. The cession of the Ionian Islands to classic Greece, the recent cession of Heligoland to Germany, show her capable of generous, even sublime, action. She can rise at times to great heights and teach nations magnanimity. All she has done of this nature combined were but little if she united the two children which her policy separated a century ago. She should tell Canada that whenever it becomes, as it is becoming, a question of separate independent existence, or of union with the other division of the race, a mother's blessing would attend union with the Republic. With the appalling condition of Europe before us, it would be criminal for a few millions of people to create a separate government and not to become part of a great mass of their own race which joins them, especially since the federal system gives each part the control of all its internal affairs, and has proved that the freest government of the parts produces the strongest government of the whole. The most eminent man in Canada to day is certainly Goldwin Smith. He remains an Englishman with allegiance unimpaired, yet he tells Britain that her position upon the American continent is the barrier to sympathetic union with her great child, the Republic. He is right.

The process of assimilating the political institutions of all

English-speaking countries should be continued, for it should never be forgotten by true Federationists that different political conditions form a great barrier to close sympathetic union. The first fruits of this movement would probably be seen in the appointment, by the various nations of our race, of international commissions, charged with creating a system of weights, measures, and coins, of port-dues, patents, and other matters of similar character which are of common interest. If there be a question upon which all authorities are agreed, it is the desirability of introducing the decimal system of weights, measures and coins; but an international commission seems the only agency capable of bringing it about. The habit of producing uniform arrangements for the whole of the race having been created by such commissions, the step would be easy to a further development of the international idea.

The Supreme Court of the United States is extolled by the statesmen of all parties in Britain, and has just received the compliment of being copied in the plan for the Australian Commonwealth. Building upon it, may we not expect that a still higher Supreme Court is one day to come which shall judge between the nations of the entire English-speaking race, as the Supreme Court at Washington already judges between States which contain the majority of the race?

The powers and duties of such a council once established may be safely trusted to increase; to its final influence over the race, and, through the race, over the world, no limit can be set; in the dim future it might even come that the pride of the citizen in the race as a whole would exceed that which he had in any part thereof; as the citizen of the Republic to-day is prouder of being an American than he is of being a native of any State of the Union. This is a far look ahead, no doubt, but patriotism is an expansive quality, and men to-day are as patriotic in regard to an entire continent as the ancients were about their respective cities and provinces. The time is coming when even race patriotism will give place to the citizenship of the world.

While the decisions of the council would necessarily be restricted to such questions as arose between the members of the race, its influence, and in extreme cases its recommendations, if unanimously made, could not fail to be of weighty import. We can imagine such a tribunal, for instance, unanimously saying a word upon occasion which would settle the most important subject

within our horizon of to-day. Is it a very improbable idea that it might hold and obtain the unanimous approval of the powers represented, in so holding that the peace of the world, in which the industrial English-speaking race is most deeply concerned, is a question which other nations cannot be allowed wholly to determine for themselves? The commanding position of our race will place upon it correspondingly great offices. United as described, it would wield such overwhelming power that resistance would be useless. Its verdict could never be questioned; its word would be law. I believe that it is by our race, and through such means, that war is most probably to be driven from the world, which it disgraces, and the reign of peace established among men for ever.

It is obvious that such an alliance of the race is dependent upon a union of hearts, and that force or pressure would only defeat it. No more seeds of lifelong bitterness should be sown. The younger members of the race should remember what is due to the parent; the parent should seek to retain their love and reverence by being "to their faults a little blind and to their virtues very kind"; freely according to each when maturity arrives the same independent existence and the same exclusive management of its own affairs, as she claims for herself, and for which she would rather sink under the sea than relinquish. Each member must be free to manage his own home as he thinks proper without incurring hostile criticism or parental interference. All must be equal. Allies—not Dependants.

Fate has given to Britain a great progeny and a great past. Her future promises to be no less great and prolific. Many may be the members of the family council of all English-speaking nations each complete in itself, which I have predicted as sure to come sooner or later; but, however numerous the children, there can never be but one mother, and that mother, great, honored, and beloved by all her offspring—as I pray she is to be—"this Sceptred Isle," my native land. God bless her!—*Nineteenth Century.*

# THE WORLD'S FAIR BUILDINGS.

*By Joseph Kendall Freitag,*

*Assistant Engineer World's Columbian Exposition.*

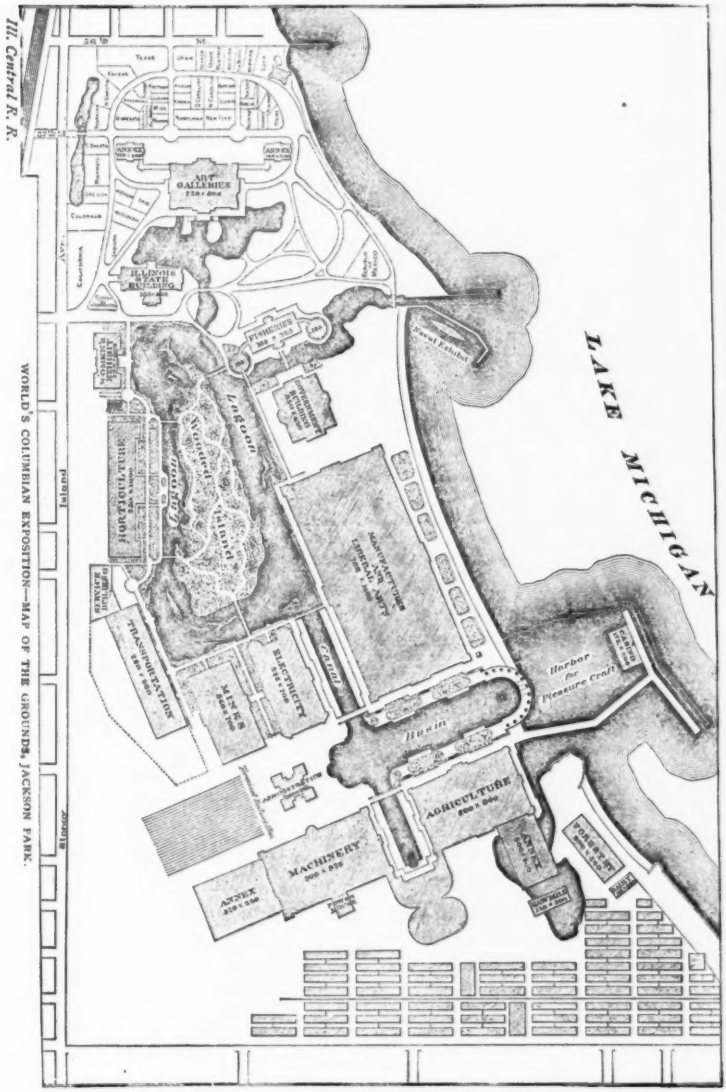
SINCE the designs for the World's Columbian Exposition buildings were approved in February last, a tract of land a mile and a half long and nearly a mile in width has been changed from lowland marshes to a uniformly-graded park, relieved by winding lagoons and gently-sloping terraces already turned to masses of lilies under the touch of the landscape architects. To those who know Chicago's spirit it seems but natural that the marshes which, but a few years ago, served as feeding-grounds for the ducks flying along Lake Michigan, should suddenly be the scene of bustle and activity, the home of thousands of workmen toiling at all hours of day and night, to the sound of creaking dredges, snorting locomotives and buzzing saw-mills. Those fortunate enough to pass the gates find within the park limits a far different scene from that presented back in the early spring months. Where rude tents then partially sheltered the laborers employed on the grading, there are now large and comfortable frame houses for the army which it is expected will be employed this fall. Three hundred carpenters for one structure seems like a breezy tale from Chicago, yet that is the number expected to be at work on the main building.

Indications multiply from day to day that the World's Columbian Exposition will incomparably surpass all previous international exhibitions. That of Paris was confessedly phenomenal in its comprehensiveness, but the scope of the exposition of 1893 is increasing so rapidly and the classification is beginning to comprise exhibits on such an enormous scale, in departments heretofore either but lightly represented or entirely ignored in great expositions, that the trouble now seems to be to provide adequate room to satisfy exhibitors. It is the aim of the exposition company to keep pace with American enterprise and to surpass all previous attempts in point of comprehensiveness of display, style and magnitude of buildings, beauty of grounds and convenience of the public.

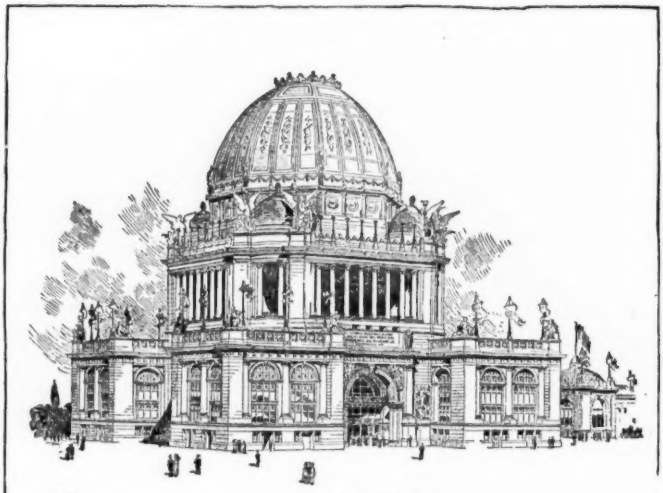
The South Park System comprises two large parks—Washington Park lying inland from the lake and connected to Jackson Park on the lake shore, by the Midway Plaisance, a strip of land some 600 feet wide and a mile long. The Fair site includes the Plaisance and Jackson Park, but of the latter, previous to the present summer, only the north end or some eighty out of a total of a thousand acres has been improved and in use. This portion of the park is shown on the map between Fifty-Sixth and Fifty-Ninth streets, and is reserved for the State and foreign exhibits, together with the art galleries. The beach at this portion of the park is shown in an accompanying engraving. The best idea of the magnitude of the site can be obtained, perhaps, from a comparison with the Centennial and Paris expositions. The Centennial covered 230 acres of ground, having 47 acres under roof, the main building requiring 20 acres. Paris devoted 173 acres of ground, the principal buildings covering 55 acres. The Columbian Exposition will embrace a thousand acres of ground 87.4 of which will be under roof (not including any annexes, State or foreign buildings), itemized as follows:

| | |
|---|---|
| Manufactures and Liberal Arts | 30.5 acres. |
| Machinery Hall | 9.7 acres. |
| Agriculture | 9.2 acres. |
| Mines and Mining | 5.6 acres. |
| Electricity | 5.6 acres. |
| Horticulture | 5.2 acres. |
| Transportation | 5.5 acres. |
| Fine Arts | 3.6 acres. |
| Government | 3.3 acres. |
| Forestry | 2.3 acres. |
| Fisheries | 2.0 acres. |
| Woman's Building | 1.8 acres. |
| Dairy | 1.7 acres. |
| Administration | 1.4 acres. |

The architectural grouping of the buildings is arranged with reference to two principal axes, the one running down the centre of the main court, from the Administration Building through the grand basin of the Casino on the pier, the other transverse to this, extending down the canal between the Manufactures and Electricity buildings, along the island to the Illinois State Buildings. The railway terminal will land the visitor in a line with the first mentioned axis, at the court opposite the Administration Building, which, with its gilded dome of aluminum as high as the Auditorium



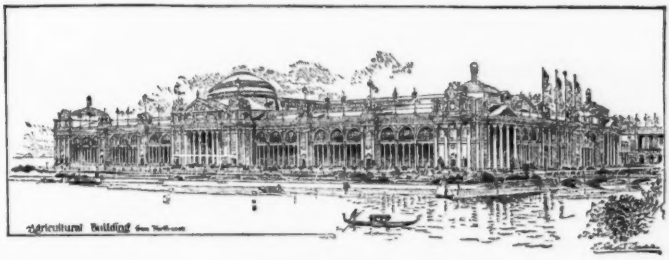

WORLD'S COLUMBIAN EXPOSITION—MAP OF THE GROUNDS, JACKSON PARK.



ADMINISTRATION BUILDING.

tower, or 260 feet, is the focus of the whole architectural scheme. It is in classic style, the first story of the Doric order, the second in Ionic, and is the design of Richard M. Hunt, President of the American Institute of Architects. It will contain the offices of the commission and local exposition company, police and fire departments, dispensary, bank and bureau of information. The cost will be $650,000. In front of this building is the grand plaza bordered with balustrades, and sloping by a series of terraces toward the basin. The principal architectural effect of the main buildings will be obtained from this court, and at night innumerable incandescent lamps will follow the outlines of the buildings.

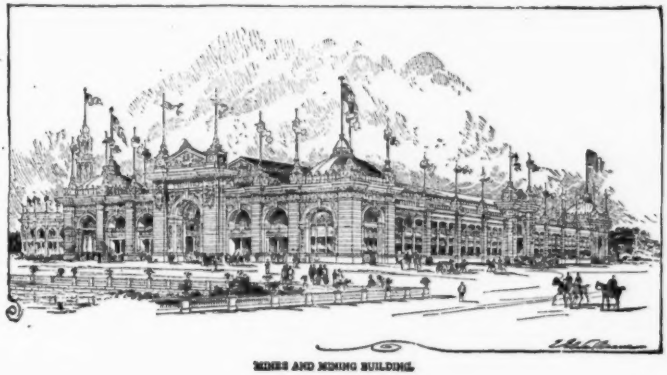
Machinery Hall, to the right, designed by Peabody & Stearns, is a bold and impressive structure, rich in architectural line and detail. It is 850 by 500 feet, spanned by three rows of arched steel trusses, surrounded on all sides by a gallery 50 feet wide. The trusses will be built independently, so that later they may be disposed of as salvage. "A grand World's Fair machinery hall—fifteen acres of Ionic architecture—which can be taken down and set up again as three union depots in as many cities. The idea is worthy of Chicago," so a local newspaper has it. In each of the three long naves is an elevated crane, travelling from end to end




AGRICULTURAL BUILDING.

of the building. After being used for handling the machinery exhibits, these cranes will serve during the exposition as travelling platforms, so that the visitor can get a constantly changing point of view. Steam power for this building will be supplied from an adjoining power house on the south side. It is estimated that 24,000 horse-power is required for the Fair machinery—8000 for the main hall, and 16,000 for the engines operating the electric-lighting, power and pumping plants, the latter of which alone will have a capacity of 40,000,000 gallons a day. Electric power will be used in all the buildings except Machinery Hall. At Philadelphia, one Corliss engine of 1456 horse-power did all the work, and Paris used but 6000 horse-power.

Nearer the shore of Lake Michigan and almost surrounded by the lagoon, stands the Agricultural Building, by McKim, Mead & White, in classic style like the rest, and of about the same dimensions as Machinery Hall, 800 by 500 feet. The general cornice line

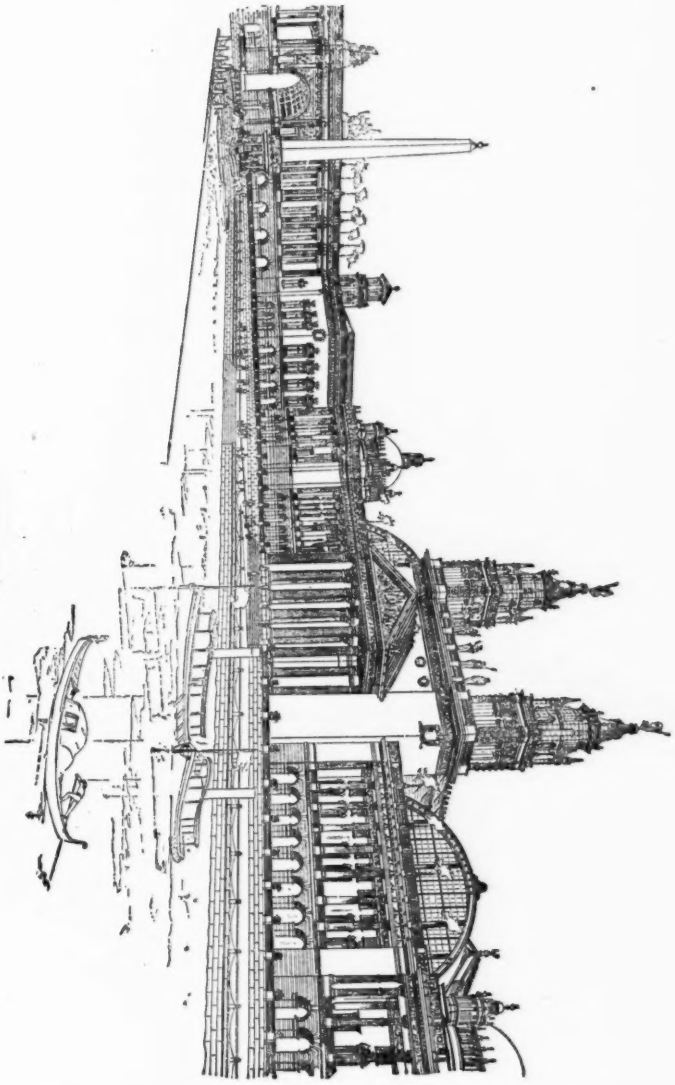


MINES AND MINING BUILDING.

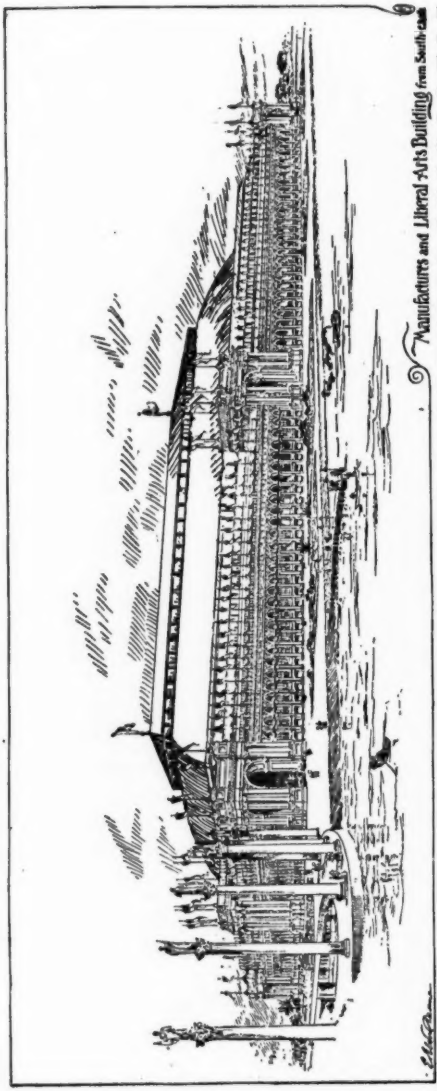
is 65 feet about the plaza. Pavilions at the corners and at the centre of each of the façades are connected by curtains, forming a continuous arcade around the building. The centre pavilion at the main entrance is 144 feet square, enclosing the rotunda 100 feet in diameter, surmounted by a glass dome 130 feet high. Groups of heroic statuary, emblematic of the agricultural industry, are grouped about the entrances and main vestibule. Between, and connecting these two buildings last mentioned, at the extreme southern end of the canal, comes the colonade, which serves as a shield and entrance to the live-stock exhibit, located at the southern limit of the park. This exhibit lying, as it does, at a lower level than the grand plaza and terraces of the main court, and behind the Machinery and Agricultural buildings and Colonade, is kept entirely distinct from the architectural *ensemble* of the building Adjoining the colonade is a pavilion or show-ring for live-stock exhibitions. Dairy, forestry and saw-mill exhibits will also be located here.

At the lake corner of the Agricultural Building, is the entrance to the pier running out 1800 feet into the waters of Lake Michigan. On its water end is to be a Venetian pavilion or casino, open on all sides, and containing a restaurant and music hall. A substantial breakwater to the north insures a safe harbor. It is expected that small boats of the various nations with rowers in national costumes will flit over the water of the harbor and lagoons, adding color and picturesqueness to the scene with their bright tints, and forming a delightful means of transportation through the grounds, leaving the visitor at steps or landings in front of any of the buildings. Looking directly west from the casino, down the basin on the main axis of the largest buildings, can be obtained one of the finest views of the Exposition grounds. At the lake end of the basin, or at the shore directly opposite the centre of the harbor, there arises out of the lagoons, a colossal statue of Liberty, surrounded in a semicircle by columns emblematic of the thirteen original States. These are being designed by Augustus St. Gaudens.

Along the lake shore and north of the harbor stands the largest of the Exposition buildings, that devoted to Manufactures and the Liberal Arts. It is in the French Renaissance, designed by George B. Post, and is a third of a mile in length, or 788 by 1688 feet. The original design contemplated a quadrangle about 200 feet wide, with a huge dome at the centre, leaving an open interior court on either side in which were to be placed the leather building and



MACHINERY HALL.



Manufactures and Liberal Arts Building from South-east

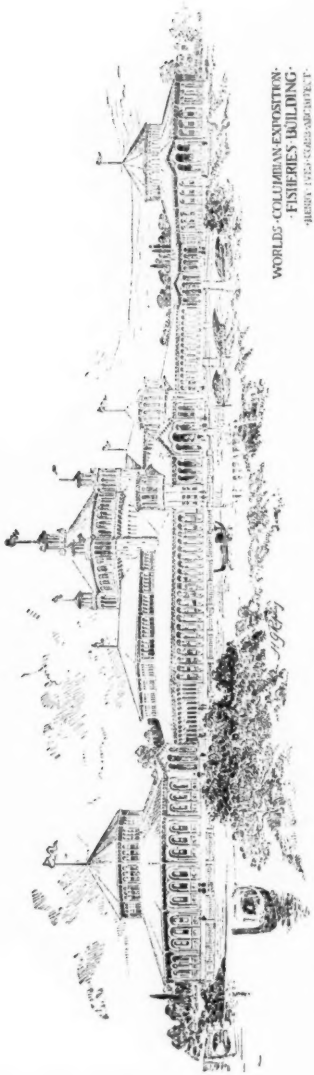
music hall. But the demand for space has been so great that the dome has been discarded, and the whole space inside the quadrangle is to be spanned by a semi-circular three-hinged arch of 380 feet span. This will be the largest roof truss in the world, being of the enormous height of 210 feet. Across the canal one will come to the Electricity Building, by Van Brunt & Howe. This is in the Italian Renaissance, 700 by 345 feet, a nave and transept of 115 feet, steel trusses, with side galleries, provide space for what will undoubtedly be one of the greatest features of the exposition. The building will present a sparkling appearance at night with numberless incandescent lights. A statue of Franklin by the distinguished Danish-American sculptor, Carl Rohl-Smith, and medallions of famous electricians will adorn the main entrance or hemicycle. The Mines

THE WOMAN'S BUILDING.

and Mining Building will be of about equal size with the Electricity, or 350 by 700 feet, and is the design of S. S. Beman. Steel cantilever trusses of 115 feet central and 57½ feet side spans form the striking feature of this building. A balcony 25 feet high and 60 feet wide encircles the building, and leading to it are light stairways.

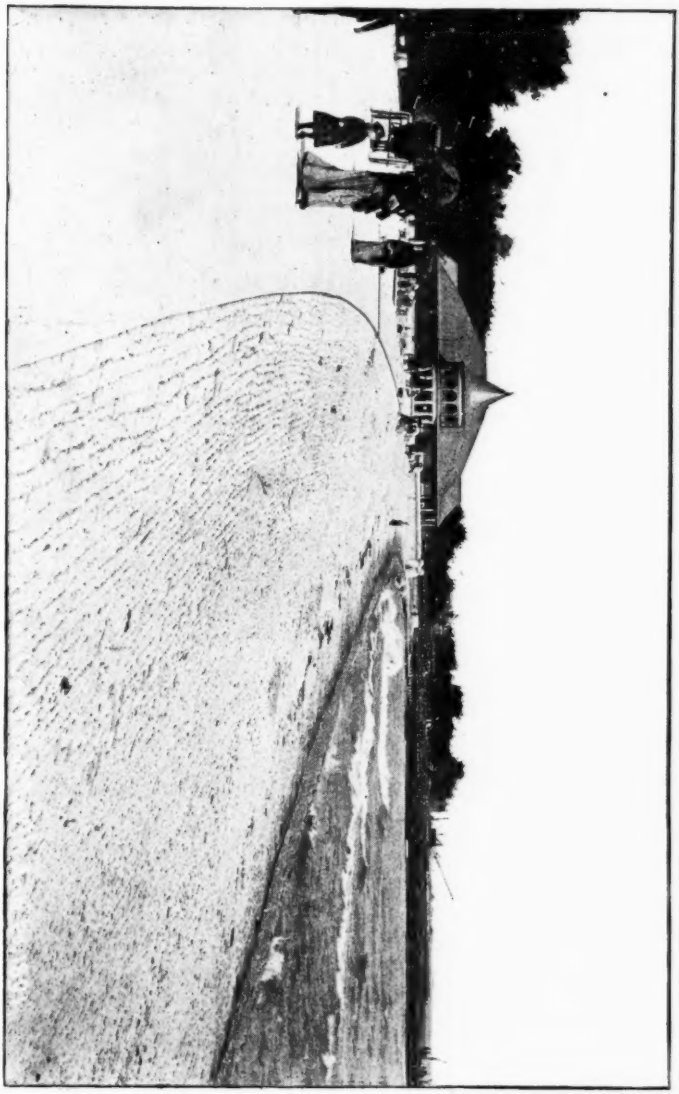
The Transportation Building lies next along the lagoon, forming a most striking edifice. It is the work of Messrs. Adler & Sullivan, of Chicago Auditorium fame. It is long and narrow, 960 by 250 feet, with provisions for large annexes of about nine acres, which will contain complete passage and freight trains. The exhibits in this building will include everything devoted to purposes of transportation from a baby-carriage to a Mogul locomotive. The design is Romanesque in feeling, the interior being treated much after the manner of a Roman basilica, having broad nave and aisles with an arcaded clerestory. The cupola, 165 feet above the ground, is reached by eight elevators which themselves form a part of the transportation exhibit. The main entrance will consist of an immense single arch, encircled with carving and bar reefs, treated entirely with gold leaf and studded with incandescent lamps. This entrance will be called the "Golden Door."

Directly opposite the wooded island lies the Horticultural Building, by W. L. B. Jenny. It is 1000 feet long by 250 feet wide, consisting of a large central dome of iron and glass, connected by front and rear curtains to end pavilions, so leaving interior open courts for out-of-door floral culture. Plants, flowers, seeds, fruits and vines will be found here. The island, as seen on the map, is entirely surrounded by lagoons, contains no buildings, but will be treated as a primæval forest or tropical wilderness, thus being in itself much of a horticultural exhibit. Extensive terraces and flower beds will border the lagoon, and in connection with the

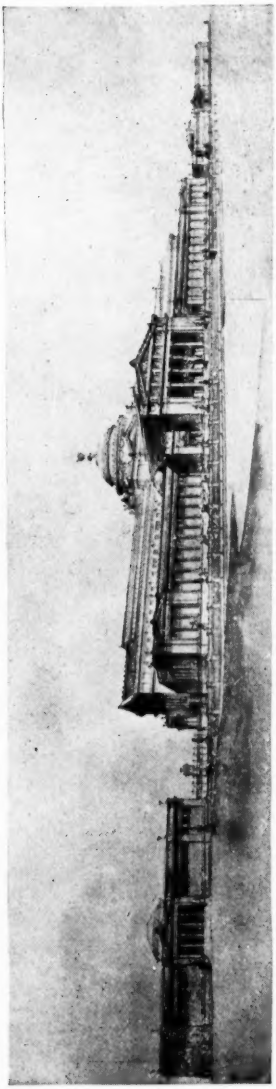



island will furnish a very extended natural display. The Woman's Building stands directly opposite the end of the Midway Plaisance. It is the work of Miss Sophia G. Hayden, the design accepted from a competition open to women only. It is in the Italian Renaissance, 200 by 400 feet, and will contain specimens of women's handiwork of all kinds, model kindergarten, reforms and charities, and a model hospital. A bureau of information, library and record room, and committee parlors for gatherings will be found on the upper floors. The Junction of the Plaisance with the park will mark the site of the Columbian Tower, 1150 feet high, the design of George S. Morison. There is still considerable doubt as to whether it will be built.

On the Midway Plaisance will be placed the special exhibits, such as a series of historical dwellings, reproductions of villages, and streets. A continuous moving sidewalk will traverse the entire length. At the head of the lagoon on the north we have the Illinois State building, 400 by 150 feet in classic design, with a large central dome. This building lies in the present improved portion of the park, which is reserved for State and foreign exhibits. Space has already been allotted and the States and foreign governments may erect buildings in combination or separately, as they see fit.



BEACH AND PAVILION, LOOKING NORTH, AUGUST, 1891.



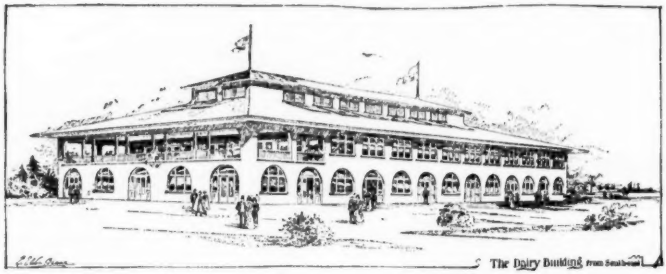
ART BUILDING.

These buildings will be designed by architects appointed by the State commissioners. Here, too, we find the Art Galleries, 320 by 500 feet, designed by designer-in-chief Atwood. They are of pure Ionic architecture, containing a nave and transept 100 feet wide and 70 feet high, at the intersection of which is a dome 60 feet in diameter, surmounted by a colossal statue.

The Fisheries Building, by Henry Ives Cobb, consists of a central main exhibit building 163 by 363 feet with curved arcades connecting with two round pavilions at the ends, each 135 feet in diameter. These will contain the aquaria and angling exhibits, immense tanks providing for a very extended display of large and small fishes, and all animal life of fresh and salt water. The building is Spanish-Romanesque, color being freely used in the design. The roofs are of Spanish tile and glass. Across the arm of the lagoon is the United States Government building, 350 by 420 feet, surrounded by camp and field equipments, the Army and Navy exhibits, lighthouse, life-saving station, and shore battery. At the lake shore, protected by a pier lies the Naval exhibit, consisting of a coast line of battle-ships of the first class, and it is hoped that the United States ship *Michigan* will be anchored here during the Fair.

This completes a hasty review of the buildings as designed up to the present time; as comprehensive a view as can well be given in the limited scope of this paper. The long beach and walk along the entire shore, the stone bridges across the lagoons, the grand entrances, the walks and balustrades lined with vases of flowers, can be but mentioned as parts of the whole scheme for beautifying every square foot of the grounds. As to the construction of these large buildings, there is perhaps little to say of general interest to architects and engineers, beyond the special features of construction already mentioned. The Bureau of Construction recognized the fact that the attention of the public is much more concerned in the external appearance than in the details of interior construction. Hence it is that our "construction" may differ considerably from an engineer's standpoint of a permanent structure, and yet, remembering that *all* of the edifices must be immediately removed at the close of the Fair, the policy of providing a larger and more comprehensive exposition by means of cheaper construc-

HORTICULTURAL BUILDING.

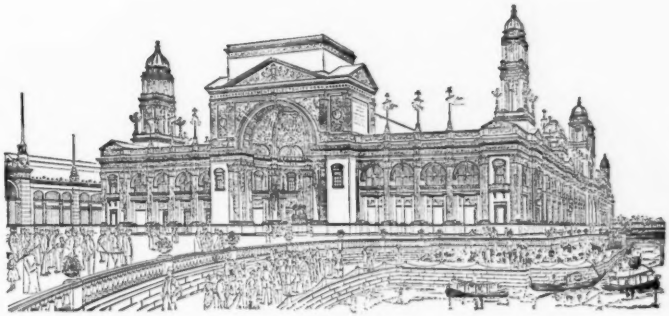

The Dairy Building from South

tion, will certainly conform to the American idea of "making the best show for the least money."

The construction is almost entirely of wood, with the exception of the large trusses and domes already mentioned. The ordinary trusses are "combination," all exterior walls being built entirely of wood, covered and protected by staff. Staff was invented in France, being used largely in the construction of the Paris Exposition of 1878. It is composed chiefly of powdered gypsum, other constituents being alumina and glycerine. These substances are mixed with water without heat and cast in moulds made from the clay models. The color is a milky white, the permanent effects being produced by external washes. All the coloring of the building is under the directions of a chief of color. The casts are shell-like, about half an inch in thickness, and can be made in very large sheets being nailed directly to the wooden construction, and then colored as desired. They are made in all conceivable forms to imitate cut stone, rock face, marble, moulding and carvings. For the lower portions of the walls, which are exposed to rough usage, the material is mixed with cement, thus making it very hard. Staff is impervious to water.

The foundations are nearly all of the "spread-foundation" type, consisting of a bottom layer of three or four inch planks, on which rests transverse layers of timbers, figured for the proper load distributed at a ton and a quarter per square foot of ground surface. The sand found at the site may be considered as practically incompressible, except in a few instances where piles are used. The main floor loads have generally been taken as very heavy to allow for exhibits of great weight. All of the large buildings have been designed with a view to realizing as much as possible at the close of the Fair, in way of salvage. Floor joists of marketable

sizes, window glass, iron roof trusses and domes will all be turned to the most practical account. The total salvage is estimated at more than $3,000,000. The work is being pushed rapidly at present, and will be carried on by two or three gangs of men working night as well as day, by electric light. Work is well under way on all of the main buildings, and the management entertain little doubt that they will be fully completed in time for the dedicatory exercises in October, 1892.



ELECTRICAL BUILDING.

# PERILS OF COAL-MINING.

*By C. J. Norwood, E. M.,*

*State Inspector of Mines for Kentucky.*

THERE is a large and interesting class of working folk who, dividing the day in accordance with the latest labor programme—"eight hours for work, eight hours for sleep and eight for play"—for two-thirds of their lives never see the sun; and on the statute-books of nearly every European country, and of seventeen States and Territories of the American Union, there are stringent laws directed towards their preservation from peculiar dangers with which they are encompassed while at their daily toil. They are the men who dig the world's supply of fossil fuel, and are more than a million and a half in number. Within recent years their field of labor has expanded rapidly, as is shown by the fact that, while coal has been mined in Europe since the tenth century (in Zwickau, Germany), and mined for sale in North America since 1770 or 1780, yet "there is now more coal used and mined in the United States, alone, in a year than was mined in all the countries of the world thirty years ago."*

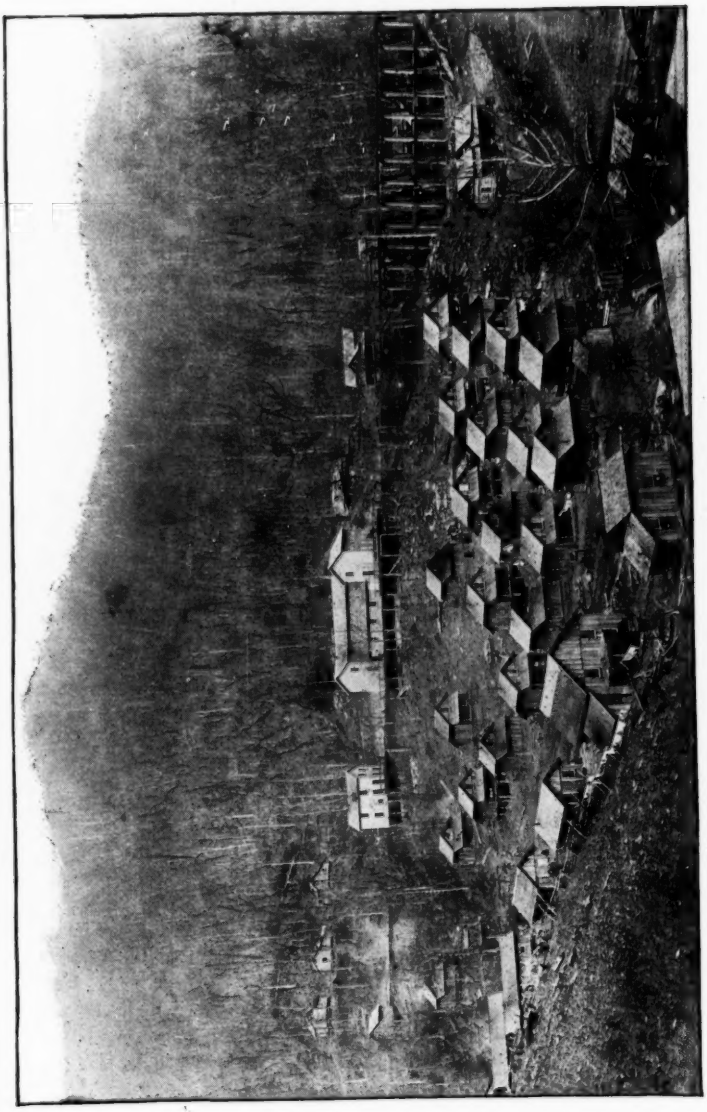
As a result of the collier's labor in 1891, the mineral wealth of the earth was depreciated to the extent of 468,600,000 tons of coal, of which 177,000,000 tons were extracted from the stores of Great Britain; 132,400,000 tons from the United States and 84,300,000 tons from Germany—these countries, in the order named, being the principal sources from which is drawn the world's supply of carbonaceous fuel.

Among the ancients mining was performed by criminals, being deemed too hazardous and degrading for freemen. It is said that the early Scotch miners were chained to the pits—a necessity at which we cannot wonder in view of the ventilative conditions under which they must have wrought. But to-day the digging of coal is recognized as an honorable form of toil, and we see the freeman contending against the degradation of his calling by the intromission of "convict labor" to the mines. The character of the collier, depends upon his treatment and surroundings. Referring, as a rule, to English-speaking, Americanized white miners, it may be said that their average intelligence quite equals that of other classes

* *The Coal Trade*, 1891, p. 105.

with no greater privileges; while the reading habit is more fully developed than is usual with the followers of other forms of manual labor. The sense of brotherhood is strong within every miner's breast, and sympathy and charity are ruling virtues. Their morals are no better and no worse than those of laborers in other fields. Considering the nature of their work, miners are more cleanly than the average worker in many cleaner occupations, there being few who do not bathe and change their garments when the day's work is done. They possess high physical courage, which, not infrequently, when fortified by the familiarity with danger that breeds contempt, tends to beget carelessness in the face of ever-present perils; leading to neglect of precautions and consequent injury. The collier is seldom a frugal man, and, the monetary fruits of his labor being small, few of his class acquire homes and a competency. Their lives are spent in an endless grind—a ceaseless, bitter fight with poverty.

Working in sombre solitude, with Poverty and Abundance as the subjects of thought, the miner is given to reflections and imaginings, and his conclusions are not always wise. He is secretive and in full sympathy with Talleyrand as to the use of language. Hence the difficulty of treaty between employer and employé. Friendly advances, intended to allay some suspected latent irritation, are, perhaps, coldly received. But it must be admitted that he has had much justificatory experience. A discharge, direct or by a system of forcing out, for a complaint, has perhaps taught him the evil of "too much talk"; and the formation of "Unions," with representatives to treat for the abatement of ills or the granting of privileges, is a natural consequence. There is an unceasing, silent antagonism between employé and employer throughout the mining world—the inevitable conflict between men striving after the same dollar, whose respective shares thereof must be increased or diminished at the expense, or in the favor, of the other. Naturally, the operator continually seeks to reduce the cost of production, while the digger, with equal reason, bends his efforts towards increasing, or, at least, maintaining the rate of his income. Imbued, therefore, with the idea—not peculiar to miners—that his employer is his natural enemy, the miner is on the alert for "additional oppression," and his heart is sore; just as the operator is inclined to view small disturbances through the medium of a compound microscope, and mistake a small blaze for a conflagration. That the miner is comparatively a patient man, as well as a self-contained



PROCTER MINE.—MINING VILLAGE OF RED ASH, KY.

one, has been shown by his conduct in the great strikes, in nearly every one of which he had the public sympathy, and by his conduct in his protest against the most intolerable form of competition to which an honest man may be subjected—that offered by the leased labor of convicts.*

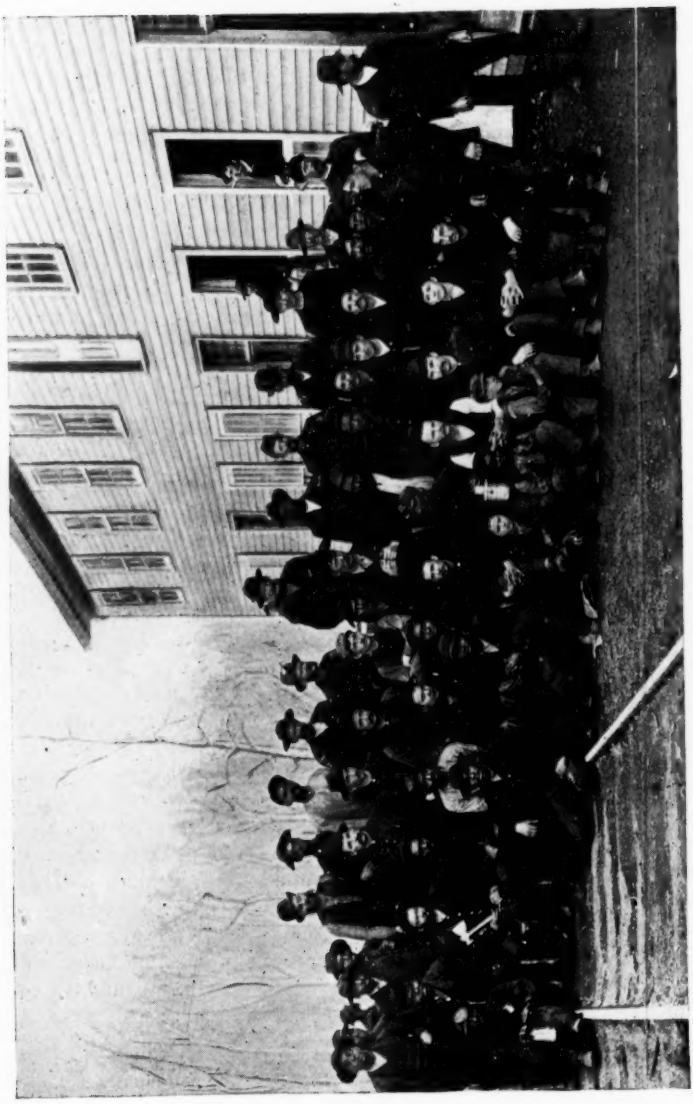
Down to more than half a mile beneath the grass many a miner goes to recover the "stored sunlight" of a preceding age, and for many it is a passing from eager life to sudden death. Aside from the ills which affect his health and make him old before his time, from the moment he enters the gloom of the mine and passes into the pitchy darkness that everywhere pervades the works the collier is accompanied by more and greater dangers than attend the follower of any other calling. Some of the special perils,—those due to exuding gases, to fires, coal-dust, falls of top, and to floods,—may be outlined here.

The harmful gases encountered in coal-mining are carbonic acid (choke-damp), carbonous oxide (white-damp), carburetted hydrogen (chief constituent of fire damp), sulphuretted hydrogen and, at times, an excess of nitrogen.

Fire-damp long has been considered the chief *bête noire* in the production of coal; but it is probable that it has often borne the blame for the deeds of another almost as deadly. By itself it may be lighted with impunity, its inflammability, indeed, seeming to have first suggested the feasibility of distilling illuminating gas from coal. But when mixed with certain proportions of air it forms a terrific explosive, by which thousands of lives have been lost. Since Queen Victoria's reign began there have been upwards of 11,000 deaths in Great Britain from mine explosions alone; and the *Colliery Guardian* asserts that had not the working systems been improved as production advanced, the deaths would have been doubled or trebled within the last twenty years.

A coal mine explosion would be a splendid phenomenon were it not so awful in its results. In the midst of peace and order—the digger in his room, plying his solitary task; the drivers urging the mules with their freight of coals along the roadways, cheerily whistling their warning of approach; miners meeting here and there to exchange a merry jest, the foremen passing to and fro to press the work forward—there comes a sudden rush of wind, a

* Convicts have been employed in a few mines in Alabama, Arkansas, Georgia, Kentucky and Tennessee. They were quickly withdrawn in Kentucky, and are, I believe, no longer employed in Arkansas.



GROUP OF MINERS—PROCTER MINE, KENTUCKY.

tremendous report as from a hundred cannon, and a flash of roaring flame sweeps along the galleries and through the rooms with cyclonic speed. What a picture of men appalled—some paralyzed with fear, others throwing themselves upon the floor to escape the rushing fire; the stunned and injured lying here and there; the shrieks of mangled victims rising in the storm; the flying, burning dust, plastering everything with a scorching cinder; the wreck of doors and timbering, the fleeing of bewildered, frantic men from remoter parts to the escapes and hoisting cages, all struggling and fighting for a place of refuge; forward and back the fiery tempest moves, and then—chaos. What a picture! All this may be told to the men above only by a muffled sound, perhaps; a slight tremor of the ground, a puff of smoke. It is but an instant, but the awful work is done; those who have not perished in the shock have, perhaps, succumbed to the silent visit of the "after-damp," and the icy fingers of Death have closed their eyes forever. A bare list of the great explosions that have been attributed to this gas would

A ROOM LOOKING TOWARD THE FACE.

A DIGGER "UNDER-CUTTING."

exceed the limits of this magazine. In single instances hundreds of lives have been lost.

A large percentage of the deaths in an explosion is due to the "after-damp," produced by the combustion. Possibly more deaths are caused by it than by the violence of the blast or the furious flame; for the flame travels in a course contrary to that of the ventilating current, since the supply of fresh oxygen necessary for combustion is afforded in that direction, while the light after-damp flows with the stream; thus overwhelming those who may have survived the shock and flame, and penetrating workings that would otherwise have escaped. Carbonous oxide (white-damp) also forms an explosive mixture with air, but it is rarely present in appreciable volume as an original element; hence it is seldom taken into account with reference to explosions. It is generated in great quantity by mine fires, however.

Though dreaded by every one, fire-damp is not in fact the most pernicious of the gases. By far more lives are shortened, by the evil wrought upon the health of miners, by the suffocating carbonic acid than by the explosive gas. Men imprisoned in *culs-de-sac* are

soon overcome, but it is seldom that lives are suddenly destroyed by it. It is insidious in its work and its effects are cumulative, but none the less certain because slow. Those who daily toil in an atmosphere unduly charged with it are soon wrecked. The vital forces are enfeebled, the system is rendered more pervious to disease, the mental faculties are dulled, and the muscles are affected. Many sudden deaths, indeed, have been caused by the gas, but the number is infinitesimal in comparison with the long list of its victims who have passed away before their prime without suspecting the cause of their early taking-off. It is a gas that must be vigorously contended with at every mine, and its presence alone would furnish a sufficient reason for inspection laws, even had their operation failed to prevent a single explosion or to save a single life from sudden extinction in other ways.

More casualties, in the even course of mining, are chargeable to falls of roof and of coal than, perhaps, to all other causes combined. The percentages in Pennsylvania for six years, ending in 1889, were as follows: Due to explosions, 12.9 per cent.; to falls, 64.2 per cent.; to other causes, 22.8 per cent.

Very many of the accidents due to falls of top are entirely unavoidable, owing to the treacherous character of the overlying shales. A heavy concretion that may be so firmly held as to resist all ordinary efforts at removal to-day, may suddenly slip from its

MACHINE MINING, EARLINGTON, KY.

MACHINE MINING, PEACH ORCHARD, KY.

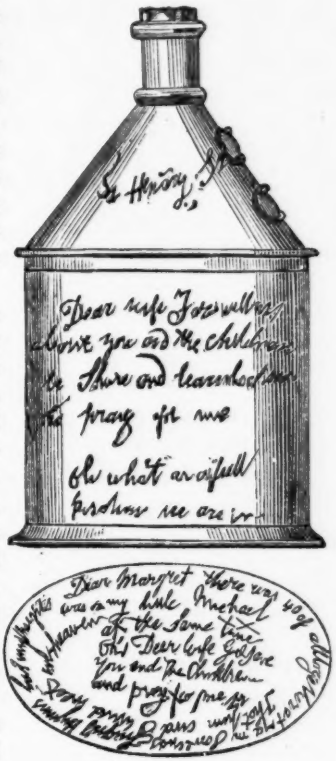
matrix with lightning speed on the morrow. But a large proportion of the accidents caused by falls of top and of coal are due to procrastination in setting props, and to a failure to support the over-hanging block of coal when reaching under to extend the "mining." In addition to the immediate danger from falling rock, there is the potential one of an explosion, due to the derangement of ventilation by the obstruction of air-ways by falls, or to the forcing of fire-damp from gassy spaces into places where open lights are used. Explosions induced in this way have occurred in many mines, as in the Central at Scranton, Pa., and the Nottingham at Plymouth, Pa.

Every dry and dusty coal mine presents explosive conditions but little, if any, less perilous than those exhibited where fire-damp is abundant. The dust not only intensifies and extends an explosion originated by the gas, but it will promote an explosion where the percentage of carburetted hydrogen may not of itself be large enough to produce one. It appears, indeed, that even without the presence of fire-damp a mixture of dust and air will explode, and a number of disasters formerly charged to the gas are now attributed to coal-dust.

The practices of "shooting on the solid" (*i. e.*, without undercutting the bed before blasting), thus increasing the probability of blown-out shots, and of using extravagantly large charges of powder, thus increasing the flame that accompanies the blast, have been responsible for some of the most disastrous of dust explosions. A considerable list might be given of explosions attributed to coal-dust, either alone or slightly aided by fire-damp. One of the most disastrous that England has ever known, that at Seaham Colliery, September 8, 1880, in which 164 persons were killed, belongs to this class. Inspectors W. N. and J. B. Atkinson, in their account of the disaster, record one of the pathetic incidents connected with it:

"Much public interest has been felt about the touching messages found recorded by some of the victims of the explosion. One of these is reproduced in the following fac-simile drawing of the tin bottle on which the miner Michael Smith scratched with the point of a rusty brattice nail the farewell letter to his wife, the size being reduced one-half:

"The message was: 'DEAR WIFE — Farewell. My last thoughts are about you and the children. Be sure and have them pray for me. Oh! what an awful position we are in. Dear Margaret, there was forty of us altogether. Some was singing hymns, but my thoughts was on my little Michael, that him and I should meet in heaven at the same time. Oh! dear wife, God save you and the children, and pray for me.'"



MICHAEL SMITH'S TIN BOTTLE.

In addition to the common ways, fires may be caused by spontaneous combustion of the waste or "gob," or of the coal itself (if "sulphurous"), and by

ventilating furnaces. When the waste is especially fine and carbonaceous, and contains much iron-pyrites, as in the case of machine mining, particularly spontaneous fires are extremely probable. At a mine within the writer's jurisdiction, extreme care is necessary, by fencing off the worked-out portions by brick "stoppings," to prevent the spread of fire from the sulphurous waste. The evil effects of a gob-fire are usually manifested only in the contamination of the air by the resulting mephitic gases; but when a fire has gained such headway as to involve the coal, and produce much "smoke," there is a pressing danger of another kind. The "smoke," being due to the distillation of the coal, contains explosive gases and is but little less dangerous than an evolution of fire-damp itself.

Dangers from floods of water arise from accumulations in abandoned or idle mines, above or adjacent to the one that is working, and from inbursts from water-filled fissures in the overlying rocks. The Jeanesville, Pa., disaster, February 3, 1891, in which thirteen persons perished, and from which four others escaped only by their wonderful endurance through eighteen days of imprisonment, is a moving example of this form of deathly menace to which the subterranean worker is subjected.

The progress of protective measures for coal miners has been slow. Indeed, only within the last half century has any considerable advance been made, though in no other field could the genius of man have found more important work. With the exception of efforts to secure the excavations from falling in, protection against explosions was the chief question with the early managers, as it is to-day in the public mind. Health demands received but little consideration. Naturally, since they were ignorant of the nature of fire-damp, knew only that its ignition caused an explosion, and did not know the great part that ventilation (of which they understood little) could perform in reducing the destructive power of the gas, their efforts were directed towards the obtention of a safe light. Phosphorescent fish-skins, mirrors for reflecting sunlight into the mine, Carlisle Spedding's "steel mill"—a device for obtaining a continuous stream of sparks from flint, and the cause of numerous explosions instead of a safeguard—had their terms of service, until Sir Humphry Davy produced his well-known lamp in 1815. It is interesting to note that the miner owes the noblest gift he has ever received to men wholly unconnected with mining affairs. Davy was a chemist; Dr. Gray, his friend, through whose immediate

efforts Davy's genius was enlisted in the miner's behalf, was a clergyman; and Mr. Wilkinson, who, in the face of popular distrust, organized the society for securing an intelligent study of explosions, was a London lawyer. The safety-lamp will, alone, keep Davy's memory green as long as mines of coal endure. But no "safety-lamp" is absolutely safe, except in careful hands, and, as has been shown by Lieutenant H. Hutchins, U. S. N., and others, the proposed electric substitute, the glow-lamp, is but little, if any safer.

Efforts for the prevention of explosions have, therefore, followed various other lines. An early method was to explode small accumulations of the fire-damp as they formed, a lighted candle, travelling on a cord, being sent into the collection. In Saxony efforts have been made to consume the gas as it issues from the coal, before an explosive mixture can form, but with very limited success. Other means, but each one defective in some essential, include (*a*) the occlusion of the issuing gas by palladium, thus securing a constant combustion without danger of explosion—Koerner's apparatus of red-hot palladium-asbestos being used; (*b*) the suction of the gas from the bed, as the mining advances, and its removal to the exterior by means of pipes and exhaust pumps; and (*c*) the saturation of the atmosphere with carbonic-acid gas before making a blast, it being known that the presence of carbonic acid, in the proportion of seven to one, will neutralize the explosive tendency of the fire-damp. But experience has demonstrated that, precautions being observed as to blasting, and safety-lamps being used as special safeguards, the only convenient and trustworthy means for contending with explosive gas is thorough ventilation. This, is, indeed, the chief factor of all efforts for rendering a mine generally secure as well as healthful, for in order that perfect ventilation may be maintained, the bank must be kept in good condition in all respects. As hitherto stated, the present tendency is to place coal-dust on a parity with fire-damp as an explosive element; but the precautionary measures are simpler than those which are necessary when the gas is present. The remedy is either to keep the roadways and working-places sprinkled with water or salt, or, as proposed by Meissner, to saturate the solid coal with water before blasting, so that no dry dust may be formed. It is unnecessary here to elaborate the precautionary measures taken with reference to spontaneous fires, fragile roofs and floods of water.

It is not singular, in view of the many fatalities that yearly occur in mines, even where inspection laws are most stringent, and

inspectors are numerous, that the layman should inquire: "Does State supervision protect, after all?" An affirmative answer, well fortified with facts, may readily be given, but must here be stated only in brief fashion.

Since the work is based upon the maxim that to prevent is better than to cure, its utility cannot readily be perceived by the superficial observer. Frequently-recurring or great disasters are widely advertised, but we do not, nor could we well expect to, hear of the innumerable instances of budding disaster that have been prevented from maturing; nor, when disaster has come, do we learn to what extent State intervention had reduced the dangerous conditions, so that the event was confined to narrower limits than would otherwise have been the case. How many of the smaller accidents occur, which are in fact purely accidental, while relieving the high tension that would surely conduce to greater casualties, we have no means of knowing. But if we turn to the history of fatalities in countries and States where the inspection laws are good and the inspection force sufficient, we find a gratifying story. For England, the *Colliery Guardian* says: "The ratios of the fatal accidents and the deaths to the number of persons employed in and about mines, under the present and former Coal-Mines Acts, show that the occupation of the miner is now more than twice as safe as it was at the commencement of the inspection." The average ratio for the first Act was one death for every 233 persons employed; for 1890 it was one death for every 530. In this country, Pennsylvania has in every respect the most comprehensive and the strongest law, and yet more fatal accidents are reported from that State than from any other section of the Union. Still the *Colliery Engineer* asserts that "there is no doubt that two tons of coal are mined now per life lost in the mines to one ton mined before the Mine Law was passed." In the region under the writer's immediate care, the fatalities have been reduced from one to every 330 persons employed underground in 1888, to one for every 405 in 1889 and one for every 604 in 1890.

But under the most favorable circumstances, the miner's life is in constant peril as he pursues

> "His dangerous labor deeper than the grave;
> Alike to him, whose taper's flickering ray
> Creates a dubious subterranean day,
> Or whether climbs the sun his noontide track,
> Or starless midnight reigns in coif of black;
> Intrepid still—though buried at his work,
> Where ambushed deaths and hidden dangers lurk."

# HAS THE LIMIT BEEN REACHED IN ARMORED WAR-SHIPS?

*By Albert Williams, Jr.*

THE ordeal of actual service will be necessary to test the merits and reveal the weaknesses of many of the recent innovations in naval warfare. In the absence of such experience we are left to form estimates as to the efficiency of the various systems of offense and defense in which the judgment must rely upon the most nearly parallel instances furnished by military history. Where such guides are not available it becomes necessary to resort to purely theoretical considerations or even to guess at what would be the outcome, in actual combat, of any given appliance or system. In the pending state of uncertainty the naval, ordnance and fortifications authorities of the great military powers naturally hesitate to commit their governments to fixed lines of policy, and the result is that less work is now being projected in extreme directions than was in progress a few years ago. One sign of the general feeling is the cessation in the building of monster guns and huge armor-clads. Indeed, it looks now as though no more 100-ton 16-inch rifles will be built, unless there should be such a radical improvement in the art of casting and forging steel as to cheapen the first cost of guns and make them more durable. It is not long since 150-ton guns were talked of, but as the smaller-sized guns of the high power attained by modern ordnance are sufficiently powerful for any work they are likely to be called upon to perform, it would be manifestly unwise to build larger ones. In order to carry armor of sufficient strength to resist even the medium guns ships of great size are necessary, and the extreme development was doubtless reached, at least for a long time to come, in the four huge battle-ships of the Italian navy, and the *Admiral* class of the British navy, which, even with their enormous displacement, are not completely protected, and are too unwieldy for general service.

The *attack* has been steadily gaining on the *defense*. At the time of the Civil War in this country it seemed as though it would be possible to construct armor-clads practically invulnerable to ordnance, however open they might be to torpedo attack. Since

then, however, great improvements have been made in artillery, the power of which has increased even more rapidly than the size, owing to the introduction of better powder, finer metal and improved construction ; while the progress in armor has been relatively slow having met with the limitation not only of the weight which can be carried, but also of the thickness which can be soundly cast and thoroughly forged. It must be remembered that the best compound and special alloy plates, those which have shown the highest resistance in experiments on the proving ground, have made their records under conditions very much more favorable to the defense than if the same plates were in position on a ship's side, where the racking effect of projectiles might be quite as destructive as mere penetration.

At present, then, the prevailing idea is that the attack is far ahead of the defense, so far as artillery and armor are concerned—to say nothing of the question of high-explosive torpedoes, submarine or aerial, auto-mobile, gun-fired fixed and in all the variety of other forms which inventive ingenuity has suggested or tried. If this idea proves to be the correct one, and no unexpected development in resisting power is soon reached, it will result in the abandonment of very heavy armored vessels ; or, rather, no more of this class will be designed and the ones now existing or building will gradually fall into disuse. In such case the war vessels of the future will be of the "protected" type, or entirely without armor except gun-shields and protection against the smaller rapid-firing guns, perhaps retaining deflective deck plating. The ships, by eliminating the weight of armor, will have just so much more offensive capacity for a given displacement. They may, on the other hand, be made smaller, cheaper and more manageable without a sacrifice of offensive power. It is on considerations of this kind that our naval constructors have given most of their attention to the development of the fast unarmored or protected cruiser type, with fairly effective battery, and moderate draft and displacement. The few United States battle-ships, like the *Maine*, *Texas*, *Indiana* and the harbor defense vessel *Monterey*, thus far projected, are of modest dimensions and cost compared with some of the European monsters—or monstrosities.

The naval problem is to a large extent a financial one. A given amount of money being allotted, the question is how best to secure the worth of the money. Is it better to concentrate it in a few large armor-clads, or divide the expense, the risk and the fighting

power among a greater number of smaller vessels, individually weaker than the big ships but handier for general service and perhaps collectively stronger in battle? Would it not be bad policy to put all the eggs in one basket, in view of the contingencies and accidents of warfare?

In the Middle Ages, when gunpowder was first introduced, the armor of knights and men-at-arms was gradually increased in weight to meet the new weapons. As the quality of powder and the guns improved armor was added to until it reached a point where if a knight was unhorsed it required several squires to get him into the saddle again, or if a man fell he could not pick himself up unaided. The next step was to limit the armor to the more vital portions, retaining only the cuirass and helmet. Finally even these were thrown away. Somewhat similar may be the transition in modern navies. The guns having beaten the armor, ships may have to discard their coats of mail and rely upon offense as the best protection, just as intelligent pugilists defend themselves by the counter rather than by the simple guard.

England, France and Italy doubtless will cease to rival each other in the race for invulnerability, and it is evident even now, from the designs proposed, that a retrogression in policy is going on. The weaker naval powers do not attempt to compete in this direction. As a rule the ships built for these latter countries are of the unarmored-cruiser class or, if armor-clads, of a comparatively light type. In building up a new navy, as the United States is doing, the most pressing need at the outset is for serviceable vessels, not merely to "display the flag" from sentimental motives, but to cover as much of the ocean as possible at the least expense and with the least delay in construction. But there is something more to be considered. It remains to be settled that unarmored vessels cannot make a good showing in action against armored ships, though persons who have not looked in the matter very deeply are apt to take it for granted that the case would be a hopeless one. It will not do to turn to the experience of the American Civil War for light on the question as it stands to-day. At that time the 9-inch and 11-inch smooth-bores carried by the wooden ships were ineffective against even the comparatively thin and weak armor against which they were pitted. The wooden vessels themselves were not at all comparable to the recent steel cruisers, having their machinery and boilers more or less exposed, being without coal protection and deflective decks and double cellular bottoms, weaker in framing

and liable to splintering and fire because of the material used in construction. Even then, with great disadvantages on the part of the wooden ships, the best of the Confederate iron-clads did not accomplish much beyond creating a great scare, although the *Manasses* and the *Albemarle* did fairly well at the outset of their brief careers. But the *Tennessee*, *Louisiana* and *Atlanta* succumbed to the relatively weak gun-fire of the time, the latter being used up by two shots from the monitor *Weehawken's* 11-inch smooth-bores. At that time the iron-clads, imperfect as they were, had greater advantages in comparison with the wooden fleets, than in all probability do modern armored battle-ships in comparison with the best unarmored but heavily armed vessels. That advantage was mainly a negative one, consisting more in the deficiencies of the wooden ships than in any great merits of their own. But since then the development of the high-powered rifle and the torpedo, together with improvements in the design, construction and speed of unarmored vessels, have materially changed the relations, the greater gain being undoubtedly on the side of the unarmored type.

There has been really very little in actual warfare within late years on which to base opinions, but that little has not been altogether in favor of the armor-clads. Thus in 1876 the British unarmored and "unprotected" *Shah* easily defeated the Peruvian monitor *Huascar*. In the Turko-Russian war the Turkish iron-clad fleet, then considered a fine one, was powerless in the Black Sea, being paralyzed by fear of the Russian torpedo boats. The *Huascar* herself in the war between Peru and Chili, made a brilliant record for a time, but only such as could have been won by an equally enterprising commander with an unarmored cruiser. In the Franco-Prussian war the splendid French fleet accomplished nothing, being kept off the German ports by the same dread of torpedoes. The English ships at the bombardment of Alexandria in 1882 were matched against badly-served and inferior ordnance, and in the Tonquin affair the French had a still easier walk-over. Besides this negative evidence, there have been accidents showing how susceptible to destruction from slight collisions the great armor-clads really are; and as to torpedo attack they are all the more vulnerable on account of the enormous dead weight of armor. What the torpedo can do was signally illustrated in Chilian waters very recently, when two torpedo cruisers defeated and sunk a heavy iron-clad, though after missing several torpedo shots at 100 and 200 yards' range.

Decisive naval actions happen only at long intervals. When the next one does occur, however, a good deal more will be learned than is now known. Doubtless some great surprises are in store for the powers which have pinned their faith to heavy armor. A few years ago, when the idea of the modern fast cruiser of large fighting power was crystallizing, an interesting series of papers appeared in the London *Engineer*, describing the imaginary "Cruise of the *Meander*," a suppositious 25-knot unarmored cruiser. The story is somewhat after the style of the famous "Battle of Dorking," and the author attempts to show what might happen in real service. Among other incidents, the *Meander* falls foul of a French armored battle-ship, the *Bayard*, and whips her, the result turning upon the superior manœuvring ability of the *Meander*, better guns and a lucky torpedo hit. What the author depicts may very reasonably be expected in combat, and his fanciful prophecy does not appear to be at all far-fetched.

There will always be a certain amount of luck in naval warfare. In a sea-way the gun platform offered by the rolling and pitching vessel is so unsteady as to make close marksmanship impossible, the chance of making effective hits depending largely upon the number of shots fired. This points to the advisability of providing a numerous battery. There is also the unreliability of torpedo fire. Hence the greater the number of guns and torpedoes, and consequently of vessels, the better. Looking at the problem from this point of view it would seem that two vessels costing $2,500,000 each, or five costing $1,000,000 apiece, ought to be more than a match for one $5,000,000 armor-clad, which, however, would not have the same number of men exposed as her adversaries. Under the law of chances, entirely apart from the intrinsic strength of the combatants, it ought to be so. One thing is certain: What might be only a repulse or a partial defeat for the side which had the fleet would be fatally disastrous if it occurred to the single ship. The argument can be extended to cover the case of a few armor-clads opposed to correspondingly more numerous light ships.

If single ships of the same cost and about the same *personnel* should have a misunderstanding, every ton of armor carried by the one would mean just so much deducted from her speed, tactical power and offensive armament, as compared with her unarmored enemy, and even with this considerable handicap upon her fighting strength she would be far from being invulnerable. No ship can

float a complete belt all around sufficiently thick to resist a square hit from a high-power 12-inch rifle, and hence belt armor of any great thickness is confined to two-fifths, a half, or a little more, of the length, and is only five to seven feet wide, thus exposing even along the belted portion the unarmored hull as the ship rolls. Ships built on the English citadel plan concentrate the protection still more, but the defenseless ends—that is, the greater part of the vessel—can be shot all to pieces by shell fire, and the ship rendered unmanageable or perhaps sunk, even though the citadel should remain unharmed.

The unarmored ship, on the contrary, is constructed not to keep out the big projectiles, but to let them through with the least possible damage. It would not make very much difference, with solid shot, what the size of the holes might be, if above water-line, through the non-vital portions of the ship ; and shells might sometimes perforate one side and go out through the other before exploding. There would be a certain amount of protection to the main battery and light shields for the smaller guns, sufficient to protect the crews from small-arm and machine-gun fire at least. Almost all the rest of the men would be in the engineer's department passing coal and managing the machinery, or in the magazines ; that is, under the deflective steel deck and below the water-line, where they would be almost safe from all casualties short of a sudden sinking of the ship. This latter disaster is nearly impossible, with the minutely subdivided cellular double bottoms of the best modern ships, since the system of construction now followed would render complete destruction a protracted affair and the men would have a fair chance to escape even if the ship were lost. But with armor-clads the problem of making them unsinkable, or of delaying the catastrophe in the event of a mortal wound to the hull, is so difficult as to be almost insuperable, owing to the enormous dead-weight of armor and the generally heavier system of construction implied by the fact of carrying that armor.

Many gallant officers of the old school are disposed to speak rather slightingly of the numerous mechanical and scientific innovations on board the latest ships, and some have gone so far as to call the prevailing arrangement a "box of tricks." They think, too, that in the rough usage of battle much of this complicated and delicate machinery may be unreliable, apt to be injured or break down when the stress comes, and the shot are flying. Undoubtedly there is a great deal of novel machinery, steam, hydraulic,

electric and what not, about a modern man-of-war ; and also much complexity about the main and secondary batteries and the wide variety of ammunition to be supplied to them ; also in regard to the torpedo service, the ventilation, lighting, search-lights, steering-gear and signalling apparatus. But these devices are labor-saving and by admitting a reduction of crew lessen the exposure of life. At all events the unarmored vessels are simpler than the armored ones and have less of this gear, since they are generally designed to perform only certain well-defined and separate functions, while the largest battle-ships are more self-contained, combining in a single vessel many diverse duties, which are specialized and differentiated in the unarmored class of war-ships.

It will be very interesting to note what will be the outcome of the numberless changes which have taken place in the construction, equipment and armament of war vessels within recent years. These changes have been so revolutionary as to well-nigh baffle preconceived opinions. Experience hitherto has thrown but little light on the question ; theory carries us a certain stage further, but there is left a very wide margin for sheer conjecture. It is for these reasons that the military authorities, the naval constructors, the ordnance experts and very many outside critics in the engineering profession are awaiting with profound interest the practical tests which the next great naval war will apply. Just now a great many well-informed and thoughtful observers are convinced that the development of naval improvements has been going ahead too fast, that a large part of the new devices adopted have not yet passed the experimental state, and that it may be necessary to make an apparent retrocession for a time by discarding some of the innovations and returning to a simpler policy.

# SILVER MINING AMONG THE CHINESE.

*By John A. Church, E. M.*

IN April, 1887, I arrived in Tientsin, China, under engagement to undertake whatever mining work might be required by Li Hung Chang, Viceroy of the Province of Chihli. It is characteristic of Chinese affairs and illustrative of the broad spirit in which Earl Li, as the English call him, administers the high offices near the throne which he fills, that in selecting my field of operations the gold regions of the Mo River, on the border of Siberia, and the copper mines of Yünnan, 1800 miles south of that point, on the frontier of India, were under discussion. In one, frozen layers of gold sands are interbedded with sheets of perpetual ice; in the other, a semi-tropical climate combines with some conditions of soil to produce virulent malaria that even the Chinese cannot withstand. Fortunately both places were rejected and I was sent to a locality in the foot-hills of the great Mongolian plateau where the chances for life and comfort were as good as a wandering engineer can hope for. In that place there were two mines noted all over North China for their former richness, called the Jêhŏ silver mines, from the town of that name, fifty-five miles distant. The principal mine was known as Yen Tung Shan (Chimney Rock Mountain) and the other was Ku Shan Tzŭ (Orphan Girl Hill). There being no road to the first, I was obliged to begin operations at the second.

The mines are situated only 140 miles in a direct line from Tientsin but the road zig-zags through the mountains so crookedly that one must travel 280 miles to reach them. These mountains belong to the Khorko range. Both mines had been worked vigorously by the natives, and the tax receipts at Jêhŏ, the provincial capital indicate a yield of 2,000,000 to 2,500,000 ounces of silver even when computed on honest returns. But Chinese mining returns are never honest. The Government tax is one-third the *gross* output, but this law is evaded by a system of Pickwickian weights. A picul of ore weighs 133⅓ pounds, but for purposes of taxation it is estimated at 266⅔ to 400 pounds, which cuts down the Government tax at once to a half or a third. Then the catty of silver which ought to contain 16 taels is made to hold 20 or 25 taels.

The upshot of it all is that the Government does well when it collects 10 per cent. of the net product. The mines are supposed, therefore, to have yielded no less than 8,000,000 ounces of silver.

This was all obtained by chiseling out the ore with hammer and moils without blasting, and the extent of the excavations made in this tedious way is wonderful. The mine at the Ku Shan Tzŭ was 750 feet long and for most of this distance it was stoped out continuously down to the depth of 250 to 350 feet. At Yen Tung Shan the extent of the works was much greater, the vein having been worked for a length of about one mile and a quarter.

Judging by what I saw of the work of native miners it must have taken a century or more of toil to produce these immense openings.

As I was expected to teach the Chinese the modern art of mining I took pains to study their methods in order to see what they were best adapted to. I found that the natives almost always squat at their work, and in my after experience it proved to be almost impossible to cure them of this habit. The miner holds his pointed chisel or moil against the rock and strikes it with a hammer weighing from thirteen to fifteen pounds. To direct such a hammer with security upon the head of a drill requires no little skill. I therefore concluded that the Chinaman ought to make a very good single-hand driller, and was not disappointed, but I found that their old practice had produced habits which were vices when applied to modern tools and methods. The American miner puts muscular force into his blow, the Chinaman exerts his muscles only when he raises the hammer; it falls by its own weight merely. I gave them five-pound single-hand hammers, and a man would pound away for hours with one of them and do nothing. The hammer was not heavy enough to accomplish anything by its weight alone, and when they were made to put force into their blow they could not aim well and the number of bruised hands was amazing. These habits were so deeply fixed in the old workmen that we had to decline their services. We found farm-hands and lads from the country much easier to teach.

There is an impression in America that strikes are unknown in China. My experience is quite to the contrary. The Chinese have invented the mariner's compass, gunpowder and strikes, but the only one of the three which they have developed fully is the art of striking. Whenever they want anything they ask for it by announcing a strike. I did not appreciate at first the importance of their feast-days

and when the first one came round they not only struck but two hundred of them came up and mobbed my house. No violence was attempted, but the interchange of views was like the chattering of ten thousand monkeys. I yielded. The miners would strike if they did not like their shift boss, strike if they had a bad dinner in the company kitchen, strike for any reason. Once when mine, mill and furnace were in full blast, the miners all struck for some insignificant cause. Tired of expostulation, I sent for the head-men and told them gravely that I had no objection to the strike if the men wished it, but that the mill and furnace could not stop. They had to go right on, and it was very costly to keep them at work without ore. I said that I did not think it was right to make the company pay this loss, and that I should fine the workmen three days pay for every day they were off duty. There was a great hubbub. The miners came to know if what the head-men told them was true. They went to work the next day and striking was free in that mine ever after, but each man paid for his own fun. In the end, however, they devised a more potent mode of warfare. They went into the mine with delightful regularity, but would do nothing when there. They put in their time but did not put out their ore, and our product fell off 75 per cent.

The gravest trouble I had with the workmen was due to the farmers. Mongolia has a small population, and the farms in the adjoining country were hardly sufficient to supply the 700 or 800 workmen needed at the mine. At first the farmers yielded us their young men with great complaisance, and the high wages we paid ($3 a month, silver, and found, to the best men) were a source of great financial ease to a community that had before struggled with poverty. At first the farmers made no unusual effort to supply the wants of seven or eight hundred non-producers. They had no faith in the persistence of the foreigner, and merely sold their surplus provisions. We bought a large part of our grain at a town a hundred miles north. Experience gradually altered the views of our neighbors. In the third year they began to plow and plant larger fields. Our men began to ask for leave or to take it without asking. They had sick mothers or dead fathers to attend to ; they had to go home to provide for debts that threatened to swallow the paternal acres, or they were sick themselves. They all promised to come back in two weeks, but not one returned. Gradually the mining force faded away. On the other hand the fields were crowded with men spading up twenty-acre lots. The farmers ac-

tually offered one to three cents a day more than we did, and agreed to give rather better food, though we had raised both wages and "chow," or rations, to a point unknown before we came to the mine.

It was useless to point out that the action was suicidal, that if the farmers prevented us from making our output, we could not buy their crops, and that the smaller our force became the less we would eat. They were killing the goose that laid the golden eggs, and with Chinese fatalism they did not care who owned the goose. I had to advise the Viceroy to import workmen from a distant province so as to be independent of the neighborhood.

Much is said about the density of population in China, but I could not see that its density improved the labor problem. It is undoubtedly easier to man a force of two or three thousand men in America than in Mongolia. A coal mine that lay within eighty miles of Tientsin, a city said to contain 500,000 people, had to send to Shantung, 600 miles away, for less than a thousand men, when the mine reached that point in its development that made the farmers near it draw their sons from its employment in order to work their increased farms.

Another interesting result of introducing activity into a slow-going, dead-alive community was shown in marketing our silver. Our operations required the monthly payment of a large sum. The effect was to make silver comparatively plentiful in a frontier region where it had been comparatively scarce. The few hundred thousand dollars we paid out increased the "visible supply" of silver in the market towns very materially. When I went to Mongolia we sold a tael (a Chinese ounce) of silver for more than 3400 copper cash. When I left we had to take less than 3100 cash for it. This falling off in the purchasing value of silver is an evidence of the very limited extent of commercial transactions in that country, and of the readiness with which local plethora or deficiency can be brought about in a community that has no other mode of exchange than the movement of silver bullion by carts. Silver is not a currency in China. It is bullion sold by weight at whatever exchange rate may rule from day to day. The currency is really the copper cash. We sent our silver bullion to the market town and there sold it for copper cash and notes of a local bank. These notes were currency, of course, but they had only a local use and were not unlike the notes of the "wild-cat" banks formerly known in America. The copper cash had the value of 1-25 of a gold cent

or 1-20 of a silver cent. One hundred dollars worth would load a mule heavily. Cash are tied up in "strings" of 250 coins, each coin representing two cash. The strings break frequently and the floor of the bullion vault was always littered with piles of loose cash.

On one occasion we failed to make preparation of cash for paying off in time to meet the exigencies of an important feast which was nearly coincident with pay-day. I had a cake of bullion fresh from the furnace cut up into small pieces and the pieces sent to the native refiner to be made into small cakes of about five ounces each. These were cut into halves, quarters, eighths and other divisions. Some were beaten out on the anvil and cut into "chicken feed," or pieces about the size of corn. With this assortment, a good pulp balance and Chinese weights every piece was weighed and its value calculated at the rate of exchange then current. In this way we paid about 200 men daily. The men liked the plan, though the shop-keepers, to whom all of them owed something, reaped a harvest of "squeezes" or petty deductions, but there was relief from the uncertain value of notes.

On the whole the Chinese workingmen were as satisfactory and submissive as I could expect. They had ineradicable faults, but these were faults that were due to their inherited condition of life. Under Chinese management the mining concession was held by one or more capitalists who were responsible for the office-men and the pumping, the latter being done by hand. All the mining work was by leases on shares. Each gang of miners worked under a head-man who was also a capitalist in the sense that he had credit assured sufficient to pay for his men's "chow" or food. Each gang had its own kitchen. Every man had his food supplied at the risk of the head-man, but that often meant only two very poor meals a day. When a head-man had accumulated ore enough for a smelting he would build a small furnace of mud bricks about two inches thick, the whole structure being not more than two feet high, sixteen inches in diameter at the bottom and ten or twelve at the top. The furnace was built over a permanent bottom well beaten and with a small basin scooped out to receive the lead bullion. One of these furnaces would smelt about 400 pounds of ore. All supplies were furnished by the office at fixed rates. They consisted merely of hearth from cupelling furnaces and charcoal. A box bellows containing a piston with a packing of feathers was rented for a few cash. Two men would blow the furnace pulling the piston back

and forth by means of long ropes which were intended to keep the men out of the dense lead smoke that poured from the furnace top especially toward the end of the operation. No flux was used though the ores were both silicious and sulphurous, and the mud walls of the furnace which were always deeply eaten did not furnish the right kind of flux. No doubt the previous roasting to which the ore had been subjected and even the smelting in such a low furnace with an abundant light blast oxidized some of the pyrite, but the principal flux was derived from the lead bottoms charged with the ore. The slag ran out continuously from the breast on the level ground, and the lead collected in the interior basin. When the ore was all smelted the breast was broken down and water thrown on to cool and save the unburned charcoal. The slag was smelted again with a new charge of lead bottoms, and a very impure lead obtained. The first and purer lead was cupelled by itself in a rude but ingenious furnace with natural draft only. The impure lead was cupelled with artificial blast through a tube curved at the end to throw the air down on the bath. They made very pure silver from the first lead, but the resmelting of the slag never gave good silver.

The silver cakes were sent to the office and sold to the proprietor of the mining concession. He received outright a certain proportion as royalty, and percentage deductions were made for pumping and office expenses, and the cost of charcoal, litharge, wages of smelter, etc., were taken out of the remainder. The silver was valued in cash and the miner was cheated both in weight of silver and rate of exchange. Then he was pretty sure to have a deduction for "litharge in the silver" and of course for inferior quality in second-class metal. I have seen cases where the miner got only 47 per cent. of his product. Out of his share he deducted the cost of his kitchen, and if there was a remainder it was divided between himself and his men according to their previous agreement. The reader will not be surprised to learn that usually the office took the whole cake to pay the royalties and for the provisions they had advanced the head-man, and still held a formidable debt over his head. The fact is the Chinese miner receives nothing but his scanty and wretched food, a brick bed to sleep on, a dollar or two every few years to buy a new supply of old clothes and one or two dollars to spend at the Chinese New Year. The head-man is expected to spend $1.50 per month for the miner's food, and the man does well who gets $7 a year for spending money.

When the foreigner assumes charge of such an enterprise he pays $3 a month and raises the "chow" to about $3 a month, so that the miner receives $72 a year. This sudden trebling of wages combined with the increase in the number of men which always goes with it is a danger to all foreign enterprises in China, for it is not accompanied by any change in the working capacity of the men. It does not immediately spur on their ambition, nor lessen the idle and shiftless habits which the hopelessness of their previous life has engendered.

One of the greatest evils I encountered was stealing. Under the contract system successful stealing was a very honorable use of talents. Habits of stealing, and the thieves' pride in a neat job, proved to be unconquerable. We suffered all the time, and illicit furnaces were in blast all around us. There was one part of the mine where the silver was found in the metallic or "native" state. A large part of the silver thus taken was stolen. Whenever a vein of this kind was found I sent soldiers to examine the men's kits and never without discovering one or more thieves. In fact, once or twice we learned from the men's bundles that a new veinlet of silver had been found. Thieves were punished when they were found, but the authorities acknowledged that the *habit* of thieving could not be broken up.

The whole subject came to a climax once when seven men, one of them a trusted "head-man," were found with our rich ore and other property of ours in their possession. The Director decided to send the men to Jêhŏ, where their fate would be beheading or imprisonment. When this news went through the camp a large party of petitioners was formed to intercede for the culprits. They knelt before the Director but found him obdurate. Finally they came to me. Outside my door I found fifty or sixty men kneeling on the ground. As soon as they saw me they prostrated themselves, forehead to earth. I went to see the Director, who said that though it seemed hard to behead men for stealing a few dollars worth of silver it was what the Chinese expected and understood and if the law was not carried out we could never hope to conquer the stealing. I noticed, however, that one delay after another occurred and the men were not sent away, but the body of kneeling petitioners seemed to be a permanent committee. The thing got to be a perfect nuisance and I presume they intended it should be.

Finally the local magistrate appeared at my house with nine of the head-men and four men from the surrounding villages and

announced that it was all settled. They had drawn up a contract by which the four outsiders were to insure the concern against loss by theft. Three of the insurers were solid shopkeepers of the neighborhood, but the fourth was some fellow they had picked up in the gutter and dressed up in good clothes which sat very uneasily on him. I had a strong suspicion that he was a head-man among the thieves. There is no such thing as individual responsibility in Chinese life. They have a most intricate system of endorsing each other's character and insuring each other's conduct. The effect is to transfer a man's allegiance from the employer and give it to the insurer, who becomes the real patron. A man in such a position will steal from his employer to give a present to the patron who insures the employer against his agent's theft. Whenever one of the countless troubles which occur in business life arose the Chinese invariably suggested the system of guarantee and I had rejected it a score of times before this, but this time they won. The magistrate produced a paper in which the underwriting four, all the head-men, the local magistrate, the Chinese Director *and myself* united in guaranteeing the mine against loss by theft! The men threatened with beheading were released.

I do not think the silent persistence by which the Chinese carried this point after two years of the strongest opposition on my part was premeditated. Their repeated return to the system was due to their inability to conceive of a different course. It takes more than two years of talk to overcome forty years or forty centuries of habit. Advanced as the Chinese are in many respects, and familiar with arts and manufacturing in the ways they understand, I do not think their mental attitude toward the methods of civilization is a whit superior to that of the American Indian. The latter is a hunter by trade and is not trained to continuous work as the Chinese are, but I think the effort to establish a given industry among the Indians would find little if any more difficulty than among the Chinese.

# THE MANCHESTER SHIP-CANAL—I.

*By George R. Dunell, C. E.*

THE benevolence of Nature in causing big rivers to flow by big cities was long ago pointed out by a philosopher whose name has been lost to posterity. There are, however, some big cities that Nature appears to have overlooked in her scheme of apportionment; one of the most notable being the English city of Manchester, the metropolis of the British cotton-manufacturing district. As our readers are aware, man has, for some time past, been busily engaged in remedying this defect caused by Nature's oversight. It was not before time that Manchester determined to have her river; or what is the modern equivalent of a river, a big canal. Of course Manchester has not been quite riverless, for it has had the Irwell's inky stream flowing past its walls. The Irwell, however, will carry nothing larger than a barge. It is canalized throughout its length.

For years Manchester meekly suffered the exactions of the Liverpool Locks and the Railway Companies combined, chiefly because there was no help for it. Manchester has not, however, always shown this meekness. In 1825, driven to activity by the exactions of the then existing barge canal, she took steps to make a ship-way of her own to the sea through the course of the river Dee. This project was revived when the Liverpool opposition was so strong that it threatened to quash entirely the present ship-canal scheme. George Stephenson, however, by the construction of the Liverpool and Manchester Railway, brought relief to the merchants and manufacturers of the district in times past and destroyed the monopoly of the canal; just as we now see a canal threatening the railway monopoly. Thus does time bring its revenges.

Our description of the Manchester Ship-Canal may be conveniently divided into two parts, relating respectively to its political and physical aspects. The former, with which we shall deal first, includes the fight before the British Parliament before the necessary statutory powers could be obtained to go on with the work, and also the financial difficulties which at one time proved all but fatal to the scheme. Although British procedure differs from that of the United States, this side of the history of the canal will not

be without interest to American engineers as showing the difficulties which their *confrères* in England have to combat.

The first important public step towards the formation of the ship-canal now in progress was a resolution passed by the Manchester Chamber of Commerce in 1877, setting forth that a better water-way to the sea was required. No practical steps were taken, however, to give effect to this resolution, which was but a truism to Manchester, until five years after, when one of the most vigorous of her citizens, the late Daniel Adamson, took the matter in hand, and called a meeting at his house. This was attended by a great many of the most important people of the district, including eleven mayors, and resulted in a committee being formed to consider plans which had been prepared by two engineers. These were Mr. Hamilton Fulton, of London, and Mr. E. Leader Williams. The scheme of the former was to bring the tide right to Manchester by making a cutting from the Mersey Estuary ; the canal thus being without locks throughout. This proposal was not approved by Mr. Abernethy, the well-known civil engineer, who adjudicated on the rival schemes, and no more was heard of it. Mr. Leader Williams, who had prepared the second proposal, was a civil engineer well known in the district. He had long been resident engineer to the Trustees of the River Weaver Navigation, and later engineer to the Bridgewater Canal ; both of which are now connected with the ship-canal scheme. Mr. Williams proposed to construct a canal with three locks, the first being at Latchford, near Warrington, the latter place being the tidal limit of the river Mersey. In the Estuary the channel was to have been carried down the centre by means of training-walls. This scheme was preferred by the adjudicator ; it being very plausibly argued that it was cheaper to lift merchandise in bulk than in detail, supposing it had to be lifted ; which would naturally be the case with Mr. Fulton's plan, as the water level would be more than sixty feet below the surface of the ground at Manchester. Mr. Williams's design accordingly was adopted, and that gentleman was appointed the engineer to the canal in embryo.

It would be interesting did space permit, to go into details of the Homeric fight which followed upon Mr. Williams's scheme being submitted to the British legislature for approval. Never before has there been such a parliamentary campaign since first the feud began between enterprise and vested interest. In truth seldom before have vested interests of such magnitude been assailed. Liver-

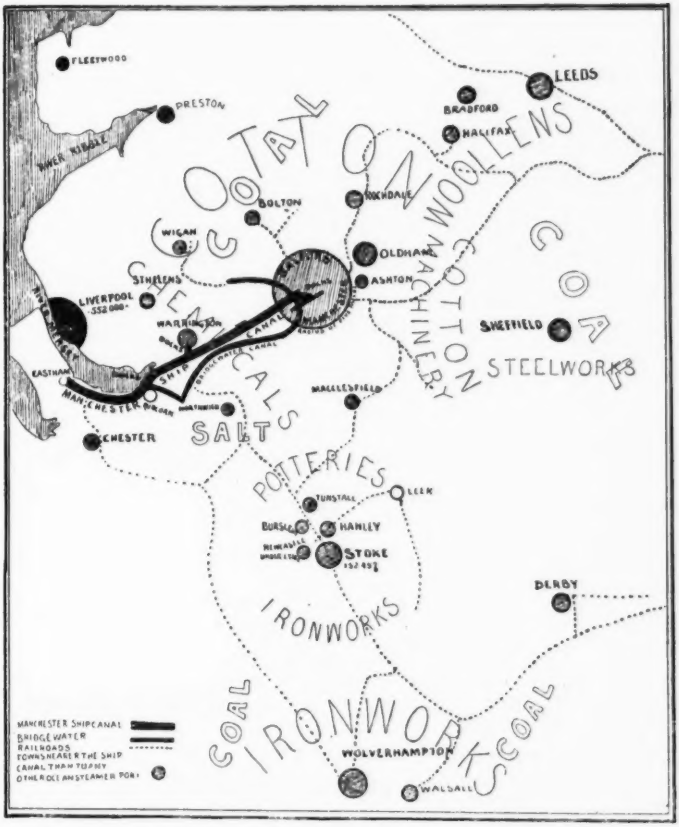
pool felt its very existence threatened. The Mersey Dock and Harbor Board thought of its dues amounting to £900,000 a year, and armed for the fray. The London and North Western Railway trembled for its £3,000,000 a year earned by carrying goods. Sir Humphrey de Trafford, one of England's great territorial magnates, remembered his thousand-year ancestral park, past which the canal runs, and buckled on his harness. The Mersey Commissioners, the Weaver Trustees, the Salt Chamber of Commerce, and a hundred other bodies all stood shoulder to shoulder to oppose this new scheme, which was to disturb so many snug monopolies and give old easy-going ways a jog.

To show how far this alarm was warranted on the part of the two principal opponents of the scheme—the Liverpool Docks and the Railway Companies—we may quote a few figures relative to the charges of these companies and those proposed for the canal company. Referring to Table I, the then cost from the ship in Liverpool Docks to the railway in Manchester, per ton of the articles named, is stated in line A ; the cost by the ship-canal to the dock quay at Manchester, after paying maximum tolls and rates, is given in line B ; whilst the saving effected by canal carriage is shown in the bottom line.

TABLE I.

| | Cotton. | Wool. | Sugar raw. | Sugar loaves. | Bacon. | Tinned meats. | Wheat. | Oranges | Petroleum. | | Timber. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | s. d. | s. d. | s. d. | s. d. | s. d. | s. d. | s. d. | s. d. | s.d. | s. d. | s. d. |
| A | 13 8 | 16 5 | 12 2 | 17 11 | 15 | 17 5 | 9 4 | 15 | 14 5 | 13 6 | 9 5 |
| B | 7 | 7 9 | 4 11 | 6 8 | 6 7 | 8 | 4 10 | 6 2 | 5 11 | 5 10 | 4 9 |
| | 6 8 | 8 8 | 7 3 | 11 3 | 8 5 | 9 5 | 5 1 | 8 10 | 8 6 | 7 8 | 4 8 |

The accompanying chart of the Manchester district, taken from a map prepared by the canal authorities, gives an excellent idea of the sources from which the undertaking expects to draw its support. The figures are not brought up to the last British census, the returns for which are not complete at the time of writing. In 1883, the imports of raw cotton were 888,000 tons ; while the exports of manufactured cotton were 4,538,888,500 yards, and of cotton yarn 264,772,000 pounds. During the same year the exports of hardware and machinery amounted in value to £13,433,081. The imports of wool for home consumption were 218,247,443 yards. The woollen exports were 255,905,700 yards and the exports of woollen yarn were 33,488,500 pounds. Since that time, however, the charges on




MAP SHOWING RELATION OF MANCHESTER SHIP-CANAL TO IMPORTANT INDUSTRIAL CENTRES.

the transportation of goods have been reduced; the mere threat of competition being sufficient to effect this desirable end, but it is fair that we should take matters as they then stood in this historical review. It should be stated that the maximum canal tolls and dock rates which could be levied on ships passing along the canal and using the docks, were fixed by the act at one-half of the then existing rates charged by railway or canal to Manchester, and at one-half of the dock and town dues charged on goods at Liverpool. In reference to this subject the figures in Table II will be of interest.

Line A refers to rates charged by the railway companies for carriage per ton of articles mentioned between Liverpool and Manchester, station to station. Line B shows the rates to which the railways would have to reduce their charges per ton of goods to obtain the traffic via Liverpool on even terms with the Ship-Canal.

TABLE II.

| | Cotton. | Wool. | Sugar loaves. | Sugar raw. | Bacon. | Tinned meats. | Wheat. | Oranges | Petroleum. | Tallow. | Timber. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 7 2 | 9 2 | 10 10 | 6 8 | 9 2 | 9 2 | 6 8 | 9 2 | 9 2 | 7 11 | 6 8 |
| B | 6 | 6 | Nothing. | Nothing. | 9 | Nothing. | 1 7 | 4 | 8 | 3 | 2 |

It will be seen from these figures that there was ample room for the canal company. Either the railways and the Liverpool docks were charging exorbitant rates, or they were totally unable to compete with the canal. It would take too much space here to apportion the blame between the railways and the docks, but this may be said: That the railway companies are money-making adventures, and their executive bodies are bound, within certain limits, to do the best they can for the proprietors. The Mersey Dock and Harbor Board stands on a different footing. It inherits its powers from the old, unreformed Corporation of Liverpool; of the days when the shipping-dues were appropriated for purely municipal purposes; and Liverpool did not pay even for sweeping her own streets. The dock trust is now distinct from the corporation. It has, however, a debt of £17,000,000 sterling; interest on which must be paid by the charges on freight handled. These facts serve to explain why the railway companies would have to carry such articles as sugar and tinned meats, from Liverpool to Manchester for nothing, in order that they might be placed in the latter city on about the same conditions as to cost, as they are to be by the coming ship-canal.

It may be urged that the promoters of the canal company have been altogether too sanguine in their estimates and that they will never be able to trade on the favorable conditions which their expectations have led them to anticipate; in other words, have not they allowed their statutory limitation of charges to be placed too low? That is a question more of interest to those who have risked their money than to the general public; but, perhaps, a few figures on this aspect of the case may be quoted with interest. It is said that the Lancashire and Yorkshire goods traffic alone of the Lon-

don and Northwestern Railway amounts to £3,000,000 yearly, and it has been argued that if this be true surely the ship-canal should be able to earn half a million a year. This sum would amount to 5 per cent. on the nominal capital of the company, £10,000,000. It was stated during the Parliamentary inquiry that if the canal were used for the carriage of nothing else but the cotton which Manchester imports and again exports in a manufactured form, merchants and manufacturers would save in carriage £456,000 annually, as compared with the existing charges, and further there would be a sufficient balance of profit to pay 5 per cent. upon two-thirds of the whole capital of the company.

One would think that with such a case as this to present there should have been little difficulty in obtaining statutory sanction to the scheme, more especially as the Ship-Canal Company had agreed to purchase the Bridgewater navigation for £700,000. But the ways of the British Parliament are devious. In the first place Mr. Frere, the Examiner of Bills, reported on January 17, 1883, that the standing orders of the House had not been carried out. The provisional committee nevertheless met and presented a petition to both houses that the standing orders might be dispensed with. This petition was supported by 38 municipal bodies, 91 local boards, 31 Chambers of Commerce and 108 public companies, besides many private individuals of influence. It is plain that though the Ship-Canal had many foes, it also had many friends.

The result of the petition was that the House of Commons agreed to dispense with the standing orders on condition that Clause 26 were struck out of the bill. Now the bill submitted to Parliament was a modification of that proposed by Mr. Leader Williams, to which we have already referred ; a part of which consisted of the construction of training-walls in the estuary of the Mersey. This work was provided for by Clause 26. As there is not depth of water enough in the upper part of the estuary to float a moderate-sized vessel, the committee, by striking out Clause 26, offered to the canal company a valueless concession ; for a ship-canal with no sea connection was an absurdity. This mutilated scheme, however, was discussed for thirty-nine days before the select committee of the House of Commons, and then the preamble of the bill was declared proven ; indeed, the committee went out of its way to volunteer an opinion to the effect that, "if the scheme could be carried out with due regard to existing interests, the Manchester Ship-Canal would afford valuable facilities to the

trade of Lancashire and ought to be sanctioned." In spite of this recommendation, however, the bill did not pass the Lords; indeed, only six out of a committee of forty peers thought it worth while to attend.

The promoters were not disheartened. Next year they came forward with a new scheme, a modification of the previous one, and this, after a discussion of forty-one days, obtained the sanction of the Lords. The locks were brought nearer the sea, but the channel below the locks was still to be carried through the centre of the estuary; training-walls being constructed to Garston, which is on the Lancashire side and opposite to Eastham, where the canal now under construction ends, and which marks the boundary of the shoals and sand-banks that so obstruct the navigation of the upper part of the Mersey estuary. With the presentation of this bill the battle began in grim earnest. No efforts were spared, no quarter was given. Money was poured forth like water. The great American engineer, Captain James B. Eads, was secured by the Mersey Dock and Harbor Board, receiving £4000 for a consultation, the biggest fee ever taken by an engineer. At this time the contest was being carried on at the cost of five guineas a minute and from first to last the amount of money spent on both sides, before a sod was turned, was approximately £350,000.

The fee paid to Captain Eads, large as it appeared, was money well spent by the opponents of the bill; for it was almost entirely on his evidence that the bill was this time thrown out by the Commons, although it had been passed by the Lords. The lower house must not be charged with inconsistency because they passed the bill of the previous year and rejected that of the next; for it will be remembered that in the previous session the clause relating to the estuary works had been expunged, and it was on this part of the scheme that the promoters of the canal were again defeated.

It was upon this estuary question that the contest now turned. The lower part of the Mersey is in form like an enormous bottle with a narrow neck. Through the latter the flood-tide rushes with great rapidity to fill the wider space above; and on the ebb returns with no less force. The scour thus formed keeps the lower channel clear and the water deep. It will be evident that were a large part of the estuary occupied by the training-walls of the canal the action referred to would be weakened, and it was said that on this account, as well as by altering the natural course of the channel, not only would the lower reaches of the Mersey become silted

up but the bar outside would grow, and the many sand-banks would increase to block navigation. These dreadful possibilities, held in threat by so great an authority as Captain Eads, were sufficient to scare the Commons, but the question may have occurred to some of the more speculative members of the committee, what would have occurred had Captain Eads's fees been paid by the other side? Would not the great engineer, who had made for the Mississippi a deep-water outlet to the sea, have been able to show how by a proper direction of the Mersey currents a sufficient channel could have been preserved, both inside and outside from Garston to the St. George's Channel? Scientific witnesses, however, must earn their fees, and it certainly was no part of Captain Eads's duty to teach his opponents how to fight their case.

The ship-canal promoters so far had no more than experience to show for money spent. But experience is a valuable thing; and after all it was Captain Eads who taught the promoters of the Manchester Ship-Canal how to win the fight. He had been asked, when giving his evidence before the committee, what he would do were he called upon to make Manchester a port. "I would bring the canal down through the land and make its terminus at Garston," he replied. This was all the canal people had got for their hundred thousand odd; but it was enough.

In the following session a new scheme was brought forward; and it is that scheme which is now being carried out and which will alter the physical geography of the Mersey valley for all time. This final scheme provided for the canal being brought through the land to Eastham, skirting the estuary shore in the lower part, where it cuts across some bays. Eastham is, as before stated, opposite Garston, the point where Captain Eads said the canal ought to have its mouth. The Liverpool people could hardly ignore the teaching of their own great witness; and after thirty more days with the Lords and thirty-five with the Commons the bill was passed, and on August 6, 1885, received the Royal Assent. Thus after an inquiry extending over two years, did Manchester obtain the sanction of the three estates of the realm to make its canal.

Although the Canal Company was so far clear of its parliamentary difficulties, it had yet a bitter disappointment in store. The next step was to raise money for the construction of the canal. As the great firm of Rothschild had undertaken this part of the business (Lucas & Curd, the big contractors, had promised to do the work for £5,750,000, or nearly half a million less than the engi-

neer's estimate) no one supposed for a minute that there would be any difficulty in raising the cash. But for once the magic name of Rothschild failed to attract the public. What amount was offered during the time the lists were opened is not known, but it must have fallen far short of the required amount to induce the great financial house to announce a failure.

The fact is, although Manchester wanted the canal badly, she did not believe in it as a commercial speculation. The great manufacturers and merchants were anxious enough to get clear of the dock and railway monopoly and have their goods carried at a cheaper rate; but they did not believe that the canal which was to effect their deliverance would pay large dividends. The shrewd Lancashire folk were quite willing to let London pay for their canal if they could derive the chief advantage from it. When, however, it was found that Lancashire must either pay for a canal or go without it there was little difficulty in getting the money. The board of directors appointed a committee of Manchester men to decide whether the company was likely to be a sound commercial undertaking and remunerative to the investors. This was answered in the affirmative, and on the strength of that decision the Lancashire capitalists filled the subscription lists. A fresh contract for the work was made with the late Mr. T. M. Walker for the same sum as that for which Lucas & Curd had undertaken to execute the work. With this step closed the first chapter in the history of the Manchester Ship-Canal. The opposition of man had been so far overcome that the engineers were free to begin their struggle with nature. It should be stated, however, that the difficulties of the promoters other than those of an engineering nature were not at an end. The death of Mr. Walker, the contractor, was a serious blow, and the canal company is now carrying on the work itself. The money, too, has proved insufficient, and the Corporation of Manchester has had to come to the rescue. It would unduly prolong this article to deal with all these subjects, and it will suffice to say that at present the work is being carried on with energy.

# THE EQUIPMENT OF PUMPING-STATIONS.

*By George W. Rafter, C. E.*

IF asked to name the most important requisite of municipal life I would answer an abundant supply of wholesome water. From such a supply flows the most marked advantages to the community—a high degree of public health, protection of property from destruction by fire and the speedy and certain removal from dwellings of waste products. Without it the vast aggregation of human beings on densely-built and compactly-populated areas which characterizes the modern city would be impossible.

The most of us are in the habit of taking the water-supply as a matter of course, and so long as we never have had any experience in a failure of it, we tacitly assume that the flow from our faucets is certain to go on, whatever may happen in the way of interruption of everything else around us. Suppose, however, that the evil day arrives which is said to come alike to all, and for the first time the life-giving stream refuses to flow either in bath-tub, wash-basin, kitchen-sink, laundry or water-closet, and suppose, too, that this condition obtains in every residence in the city, and that at places of business and in manufacturing establishments it is equally impossible to get the customary flow from the service-pipes. Under this state of affairs everything stops until the water supply is resumed. In private houses, where cooking-ranges are fitted with water-fronts, people find it impossible to prepare a meal of victuals until the water-front is disconnected and removed, an operation requiring the plumber or the universal tinker, both of whom certainly have more on hand than can be done at such a time of popular discomfort. Private residences and business blocks warmed by steam of necessity go unwarmed until the water-supply resumes its customary flow, and in manufacturing establishments depending upon steam for power it is equally impossible to proceed with the ordinary tasks while the deficiency lasts. The whole life of the municipality is seen thus to depend upon the maintenance of an uninterrupted supply.

When pumping machinery is required as an integral part of a water system, the providing of the same in such wise as to insure absolute immunity against interruption becomes the most important duty which the municipal authorities have to perform. In the United States and Canada there are about fourteen hundred towns,

the water-supply of which involves some form of pumping. The question of how to select the best machinery for the purpose probably has perplexed the authorities of most of these towns, either when the works were first constructed or as renewals and extensions have been required, later on. Without attempting to explain in detail how this and allied questions are settled by engineers, I may still indicate in a popular paper some of the points which may fairly claim attention from those charged with the purchase of machinery and the installation of a pumping plant.

In case a new station is to be installed, as in first constructing a public water-supply, the quality and quantity of the proposed source should first claim attention. It is absurd to go to the large expenditure attending the construction of water-works without knowing positively that the best the region affords is going to be obtained. How this will be determined where there is a choice of several sources is a matter for special experts. The quantity will depend upon circumstances. American towns may be considered as demanding a daily supply of from 65 to 100 gallons per inhabitant, and the character of the population and the industries of the town will determine just what figure to use. Where towns are increasing rapidly in population the rate of increase for a past term of years will furnish a basis for estimating the population at some period in the future for which it is considered desirable to make provision in a new construction.

If the source of supply is from a large river or lake and the town to be supplied is one of moderate size the question of certainty of quantity settles itself, but when the total quantity becomes large, as in cities like New York, Boston and Philadelphia, and the stream from which the supply is to be taken is of moderate flow, the question of certainty of quantity may be one fraught with great difficulty. If it is proposed to take a supply from open wells it should be understood at the outset that such a source is frequently quite experimental and that it is often impossible to say whether a given well will be permanent until after a considerable period of pumping. Ponds and small lakes should be studied in reference to the amount of area drained and the probable yield from the same in years of minimum rainfall. Gang wells and filter galleries like open wells should also be looked upon as experimental until they have been proven by use.

We come next to questions in connection with the location of the station. Throwing deep-well vertical pumps out of consid-

eration we can say that the pumping-station ought to be so located as to bring the pumps as near water-level as possible, though this condition is sometimes difficult of fulfillment, especially on streams with wide range of height between the flood and dry-weather flows, where frequently the only alternative is a vertical engine, specially designed to meet each case. By locating the pumping-station as near water-level as possible we gain in a mechanical way the advantage of getting behind the water at the earliest moment, thereby securing an opportunity to push rather than to pull. Eighteen to twenty feet may be considered the practical limit of suction for large machines, although about thirty-four feet is the theoretical limit at the sea-level.

Before deciding upon the type of machine to use it will be necessary to decide upon the maximum quantity per unit of time that may be reasonably required. The domestic and manufacturing use we have already stated at from 65 to 100 gallons per inhabitant per day, and experience indicates that about half of this use takes place in the eight hours from 8 o'clock in the morning until 4 in the afternoon. Fire streams are estimated at 175 gallons each per minute and the number to be provided will depend upon the special conditions obtaining. A residence district, with detached villa houses, demands a smaller number than would be required either in a compactly-built tenement area or a manufacturing town. All these points and many more have to be taken into consideration and general views have relative value only.

The question of where the water is to be delivered will be of considerable importance in deciding what type of machine to use. If into a stand-pipe or reservoir, the conditions are quite different from those obtaining in direct-pumping systems. A pump delivering a given quantity per unit of time to a stand-pipe or reservoir has uniform work, while, when delivering into a distribution system direct, the discharge and the work are of necessity constantly varying. Before installing a new station, therefore, the merits of the different systems of pumping ought to be fully understood, as upon the choice of an engine best suited to any given use will depend in a large degree the amount of the annual expense. If water is to be pumped into either a stand-pipe or reservoir the distance of the pumping-station from the point of delivery will be considered in determining the size of force-main connecting the station with that point. Strange as it may seem to the non-professional reader, the resistance of the flow of water through such a main will not be meas-

ured by the mere difference in height between the pumps and the point of delivery. The resistance will always be greater, the amount of excess over that due purely to difference in elevation, depending upon the size of force-main, its length and the quantity flowing through it.

By way of making clear this proposition, I will amplify a little, assuming the case of a pumping-station the uniform work of which is to deliver 6,000,000 gallons of water a day through a 24-inch main into a reservoir, the normal water surface of which is 200 feet above the centre of the pumps and the point of delivery horizontally distant 20,000 feet from the station. With the reservoir full to its normal height and the force-main connecting the pumping-station with it also filled with water, a pressure-gauge located in the station at the level of the pumps would indicate, while the pumps are standing still, a pressure of 87 pounds. With the pumps running and the delivery at the assumed rate of 6,000,000 gallons daily the same gauge would show a pressure of 98 pounds. The first indication of 87 pounds marks the amount of the static head, or the pressure due to total vertical height of water above the gauge, while the difference of the first and second readings, amounting to 11 pounds, indicates the friction head, or the amount of resistance which the pumps overcome by reason of friction of the flowing stream against the sides of the main. So far so good, but let us consider the future a little. In the course of time the town which the assumed pumping-station supplies increases in population and 6,000,000 gallons are insufficient for the daily wants. More powerful machinery is purchased and a continually increasing quantity of water sent through the original force-main, until after a few years the daily delivery reaches say 12,000,000 gallons. With this latter condition our pressure-gauge shows a reading of 131 pounds, from which we conclude that with 12,000,000 gallons daily delivery the friction-head is 44 pounds, as against 11 pounds when the daily delivery was only 6,000,000.

With the larger quantity the velocity of flow is of course double what it was with the smaller, while the frictional resistance is four times as great, and hence we reach a practical exemplification of the law that *in mains of a given size and length the resistance of friction increases as the square of the velocity of flow.* If our assumed 24-inch force-main were only 10,000 feet in length we would find the pressure gauge showing 5.5 pounds increase over the static pressure for a delivery of 6,000,000 gallons daily, and 22 pounds

when the daily flow reached 12,000,000 gallons. From this we further learn that *in a main of a given size for a given flow the frictional resistance increases directly as the length.*

We learn too from this discussion that an increase in the use of water to double what it was originally adds to the work of our pumping-stations an amount more than double that done at the beginning, the extra increase in work being represented by the additional resistance due to friction. The practical deduction from this is that for the pumping system of a public water-supply in a growing town, a failure to make the force-main large enough in the beginning will finally lead to trouble at the pumping-station.

It has been quite the fashion to take the ground that ordinary commercial considerations have little place in determining questions relating to the installation of a pumping-plant in connection with a public water-supply. The proper course seems to me to be exactly the opposite, and the pumping-station best suited to any given case is the one which under any and all conditions will do the required work and keep the total expense, including the first cost and capitalization of the fixed charges, at a minimum. To ascertain just what machine will do this we must know the price of fuel at the given point and many other items in addition to those already mentioned, which may assist in determining the class of machine needed. Only by taking into account all the data, however, can the best solution be obtained. The difficulty of deciding without a clear idea of the relation of the various machines to the work to be performed may be illustrated by taking the catalogues of a few of the prominent makers, where we find listed what to the uninitiated will seem a bewildering array of machines of various types. One manufacturer makes a specialty of pumping-engines of the horizontal type and lists (1) duplex non-compound horizontal pumping-engines; (2) duplex compound horizontal pumping-engines; (3) the same with crank and fly-wheel and (4) condensing engines with jet condenser or independent surface condenser as the case may be. The same maker has also built a number of machines designated as compound quadruplex pumping-engines. Another firm makes a specialty of vertical pumps, and according to its catalogue builds vertical quadruple, triple and compound expansion engines. A third leading manufacturer describes his machines as (1) compound, expanding and condensing engines; (2) expanding non-condensing engines and (3) high-pressure engines without expansion or condensation.

The space still available will not permit a description in detail of the peculiarities of all these machines with an indication of wherein one type possesses superiority over another. In a general way it may be said that the largest item of expense at a pumping-station is the coal bill. Economy in this item follows from the use of high-grade expanding and condensing engines. Such machines, however, are much more complicated, and the first cost for a given work is always greater. The simplest form is found in direct-acting high-pressure engines, working without either expansion or condensation, and likewise these machines may be bought for the smallest first cost.

This brings us to the question of duty and as a short statement of the matter we may say that the duty of a pumping engine is the number of foot-pounds of work done per unit of weight of coal burned in the furnace. By common consent the unit weight is taken at 100 pounds, and the duty accordingly becomes the number of foot-pounds of work performed in the way of lifting water by the consumption under the steam boilers of that number of pounds of coal. Hence when a pumping engine is spoken of as having a duty of say 60,000,000, the idea to be conveyed is that the machine is competent to raise that number of pounds of water one foot high with the expenditure of 100 pounds of coal under the boiler. The financial value of duty may be appreciated by considering that the best type of high grade expansion engines give a duty in regular continuous service of say 100,000,000 ; ordinary condensing-engines rarely exceed 50,000,000, while direct-acting pumps fall as low as 15,000,000 to 20,000,000. This leads in a practical way to the conclusion that the best type of engines will pump a given quantity of water with an expenditure of about one-fifth the fuel required for the ordinary types.

By way of illustrating this we may again refer to our assumed station pumping 6,000,000 gallons daily 200 feet high, or taking into account the frictional resistance in the force main, we pump same as against 226 feet without friction. We will assume the price of coal at $4 per net ton delivered at the station. In case an engine yielding 100,000,000 duty is used the annual cost of fuel will be $8260, while for a machine of 50,000,000 duty the fuel bill will be $16,520. The difference of these two amounts is $8260. Most towns in the Northern and Western States have no difficulty in borrowing money for the construction of public works at 4 per cent., and using this rate we find that the capitalized value of the

saving in fuel would be $206,500; that is to say the excess in expenditure for fuel for the 50,000,000 duty engines would pay the interest on more than $200,000. With a decrease in the price of coal the difference in value of different duties becomes less and less, until in the coal regions where fuel may be had for about $1 per net ton it may become quite as cheap to use a machine of low duty. It is only by the proper balancing of these opposing conditions that one can arrive in any given case at the best solution.

The foregoing gives in a very incomplete way some of the points to be considered when installing a new pumping-station, and I hope I have succeeded in making the very limited portion of the subject treated here fairly intelligible to the general reader. In any case the conclusion may be drawn from what is said that the problems to be solved are not simple ones, and safety together with the best solution will usually be insured by following the advice of those who have given the subject special attention.

THE NEW MUSEUM BUILDINGS AT SOUTH KENSINGTON,

# MUSEUM BUILDING AND ARRANGEMENT.

*By Barr Ferree,*

*School of Architecture, University of Pennsylvania.*

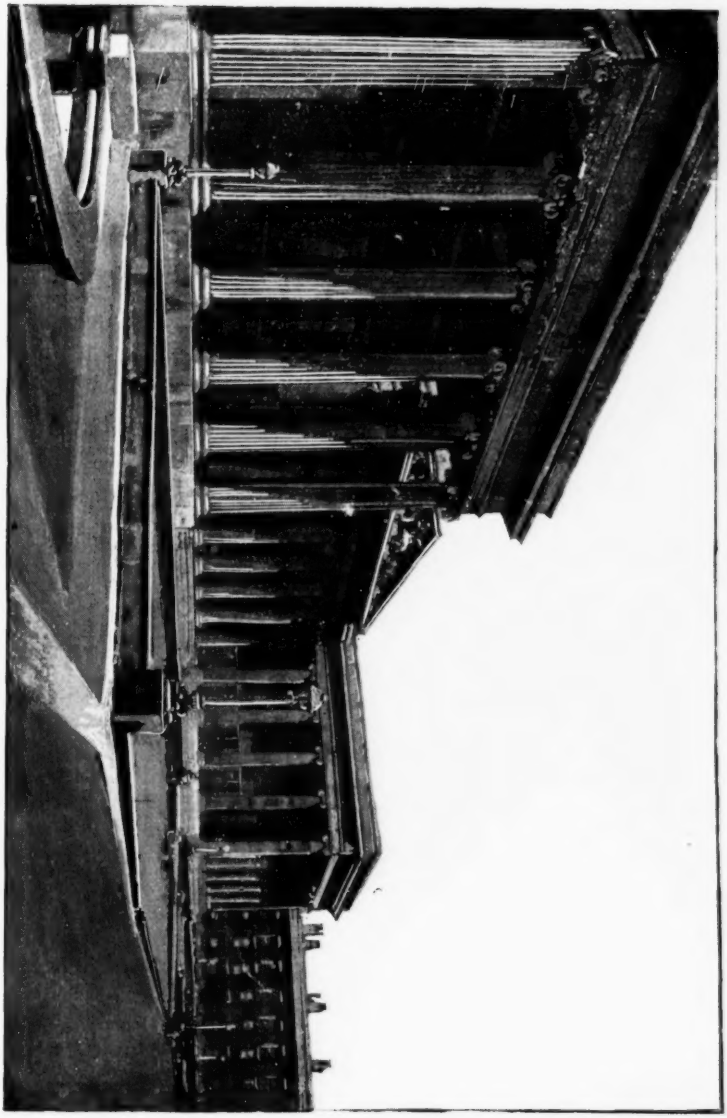
IT is a peculiarity of museums that they are no sooner built than they become inadequate for the purposes for which they are intended. This is indeed true of other classes of buildings but of none other is it so generally characteristic. No matter how limited in scope a museum may be, its object is the accumulation of everything under the sun that relates to its special subject. It is a storehouse for present and future knowledge and it is impossible to exercise too careful a discrimination in selection, for what has little or no value to-day may be of the greatest interest and importance a few years hence. Thus a museum building really requires to be self-expansive, for the largest endowments are not

THE TROCADERO, PARIS.

PAVILION SULLY, LOUVRE.

sufficient to provide structures ample enough to accommodate unknown treasures.

The great modern museum, typified by the British Museum and the Louvre, is of comparatively recent origin. The former dates from 1753 and the latter from 1793, but their periods of richest accumulation were much later. Both occupy immense buildings and by reason of the nature of their possessions as well as their extent easily rank first among the museums of the world. Yet though

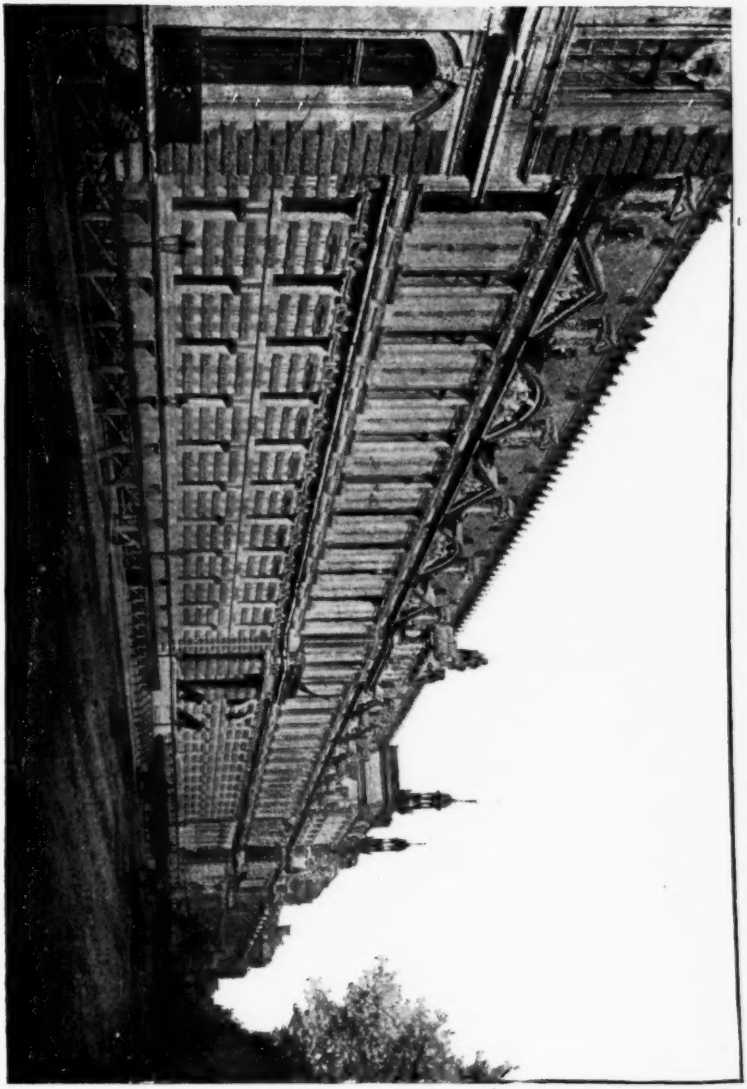


THE BRITISH MUSEUM.

they have always been in receipt of ample and frequently abundant support from the government they are far from offering models in the plans or arrangement of their buildings. The Louvre is a palace, built as such and intended to be used as such, and while it has received very considerable additions since it was set apart as a museum, it is not justly open to criticism as a museum building. The British Museum, however, was built expressly for museum purposes and without stint of money, and if not the model museum building in the world has had every opportunity of becoming it.

The British Museum is chiefly a archæological, the collections in natural history which formerly formed a very large part of its possessions having been transferred to a special museum at South Kensington a few years ago. Apart from the library of manuscripts and printed books it is therefore almost wholly an art and archæological museum. In plan the building is a series of narrow galleries, sometimes double, sometimes single, surrounding a large quadrangle which though originally planned to be open is now economically utilized by the Reading Room. As a whole the plan is simple and elementary and has become typical for a museum. In a museum of paintings, as in the picture galleries of the Louvre, where wall space is essential for the display of the objects, the long narrow corridor is the best form and the only one, but for a general museum like the British it is far from being the most desirable.

So far as the plan of the building permits the arrangement of the British Museum is as good as possible, but it does not bring together all the objects of one class, nor all the products of one people or time. Generally speaking there are but two ways of arranging a museum : historically and comparatively. In an historical arrangement the objects are grouped nationally, everything produced by one people being brought together in one place. Thus, for example, the smaller antiquities of Greece, the vases and bronzes, the terra cottas and jewels and similar remains would be placed with the sculptures and paintings, if not in the same gallery, in adjacent ones. In a comparative museum all the objects of one class from every nation and time would be placed together. Thus a ceramic museum in which the pottery and porcelain of every people are shown chronologically and geographically is comparative. Both methods have their own value and each is the better according to the scope and purpose of the museum or its extent. The British Museum, and indeed most general museums, is neither

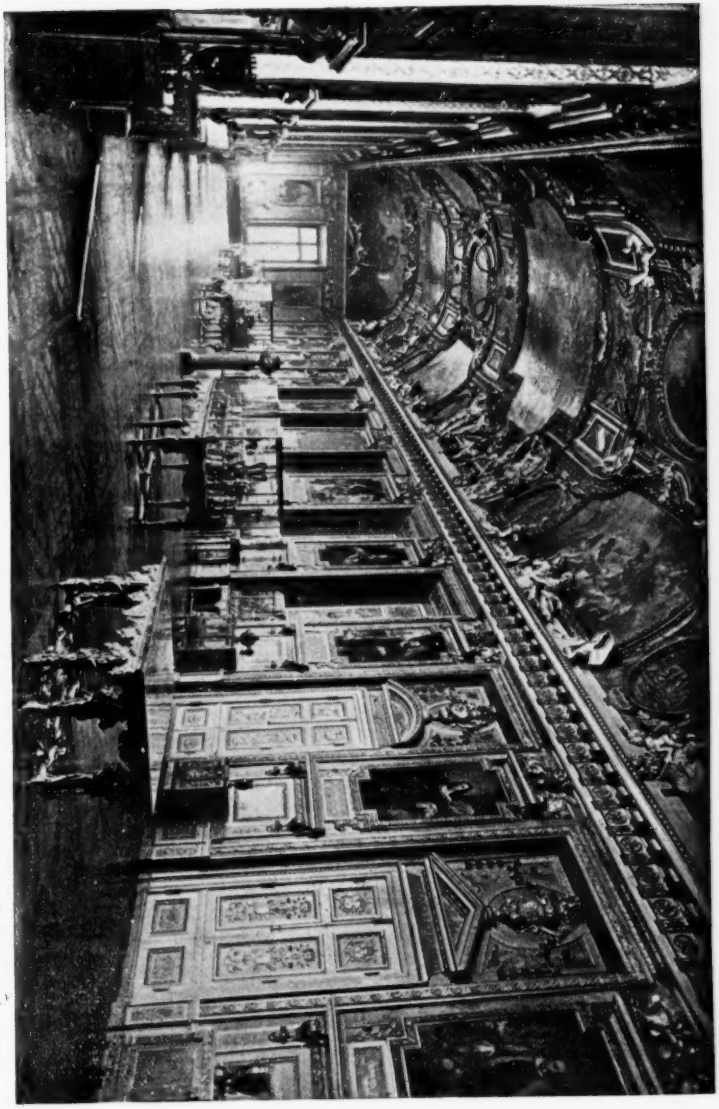


PART OF THE LOUVRE, PARIS.

the one or the other. The student bent on investigating the antiquities of Egypt will find them in two places wide apart from each other; the smaller objects on the upper floor, and the larger, chiefly sculptures, on the ground floor. Though there is a distinction between the two classes it is more a distinction of size than of difference in specimens, for no one studying Egyptian sculpture as a whole could ignore the innumerable small objects that crowd the cases of the upper galleries.

It is the same in the Louvre, where the greater size of the galleries and the larger collections render the methods more inconvenient than in the British Museum. In the Louvre another method is illustrated which is not unknown in its great English rival, that of keeping intact certain collections, no matter how varied they are, or how closely they may be related to other parts of the museum. The Musée Campana in the Louvre is an extensive collection of Asiatic, Greek, Etruscan and Roman antiquities, and is really a museum within a museum. To ascertain, therefore, what the Louvre possesses in Greek antiquities, it is necessary to look in three different places, in the sculpture gallery, in the galleries of smaller antiquities, and in the Musée Campana. This system exists in all large museums and is the result of the purchase of special collections or is the stipulation of donors who desired their name perpetuated with the objects they have gathered. Neither of these reasons is sufficient for maintaining an unscientific arrangement nor for subjecting the student to unnecessary labor and research, but it is probably beyond the power of museum authorities to regulate it. The double system arises further from the impracticability of distributing heavy objects, as sculptures, irregularly throughout a building, but a museum building should conform to its contents, not its contents to the building.

The South Kensington Museum is even more unsatisfactory in its planning than the British. Its collections are more varied, and more numerous than in the older institution. It is a museum of industrial art rather than of antiquities, though its scope is wide enough to include almost everything. The buildings are an extremely irregular group of permanent and temporary structures, built apparently on no general plan and as special circumstances or special funds permitted. The temporary character of a large part of the galleries necessarily forbids criticism of the whole, but the general plan is a series of corridors or narrow halls surrounding courts, most of which are utilized for exhibition purposes. Few

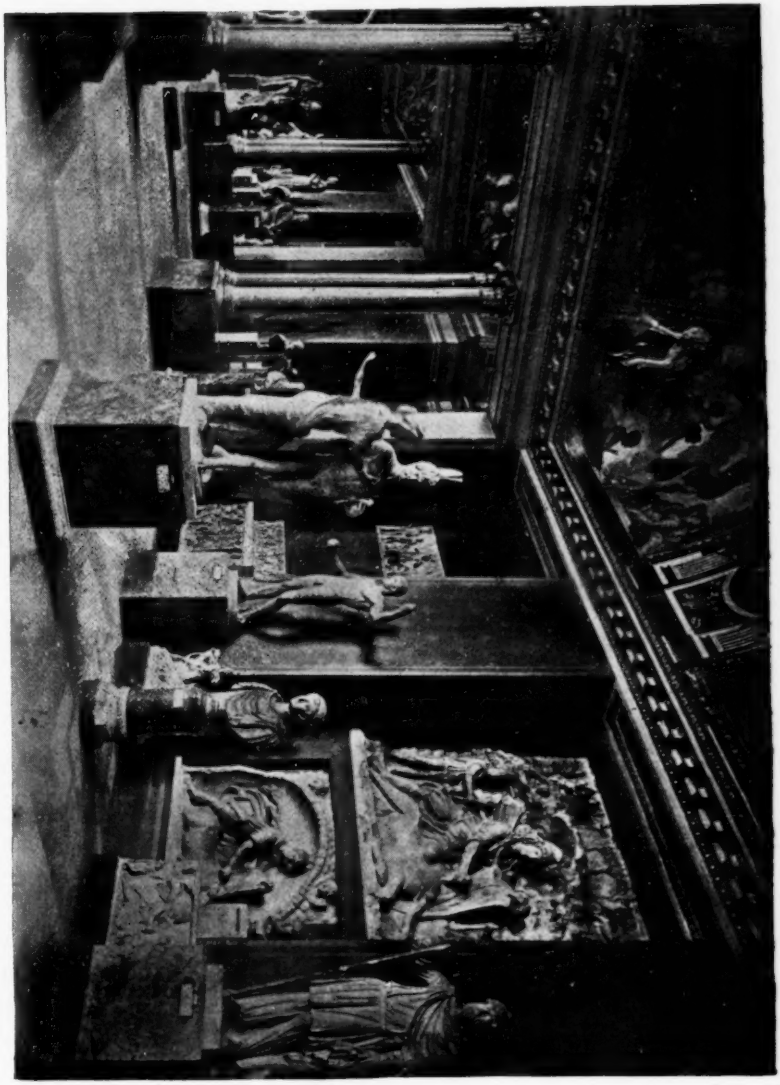


THE APOLLO GALLERY, LOUVRE.

museums have grown as rapidly as the South Kensington—it was founded in 1855—but its abundant riches are not only a source of pride to its authorities but a continually increasing embarrassment. It is quite beyond their power to display what they already have to any advantage, and fresh objects are being constantly acquired. The courts and galleries are crowded to an extent they never were intended to be, and their value is seriously injured in the manner in which they are literally packed into the rooms.

The faults of the corridor system are nowhere better illustrated and nowhere call for more immediate remedy. Plans for improvements and additions have been before the authorities almost without intermission since the Museum was organized, and within the last few months a final competition has been held in which many of the most eminent English architects participated and in which the accumulated experience of years have been drawn on to obtain the best possible results. It is not unnatural to infer that a museum building planned and designed under these circumstances and under such favorable and important auspices would be a model structure correcting the errors of previous edifices and if not providing for further extension at least permitting it. This last is, indeed, apart from a judicious arrangement of the objects, the one great question in museum architecture. Time and again experience has shown the futility of erecting a structure which will last for a reasonable period. The rapidity with which museums acquire objects is too irregular to be determined in advance, and it is quite possible to erect an edifice ample enough for present needs but altogether useless for what the museum may fall heir to the day after it is completed. A museum building must thus not only take the past and present into account but the future as well. The present generation is not called upon to build a structure for posterity, but to so plan its structures that posterity will not be put to unnecessary expense and trouble in modernizing our buildings.

The plans for the new permanent buildings at South Kensington do not take this important and necessary element into consideration. They are planned on the familiar basis of corridor and court, the latter, as in the present buildings, being largely used for exhibits. In this way every part of a large rectangular ground floor is used in a really economical manner. Though there was much similarity in the plans submitted in this competition, which was one of the most important recently held in England, there was great diversity in the façades. Several were thoroughly fine de-

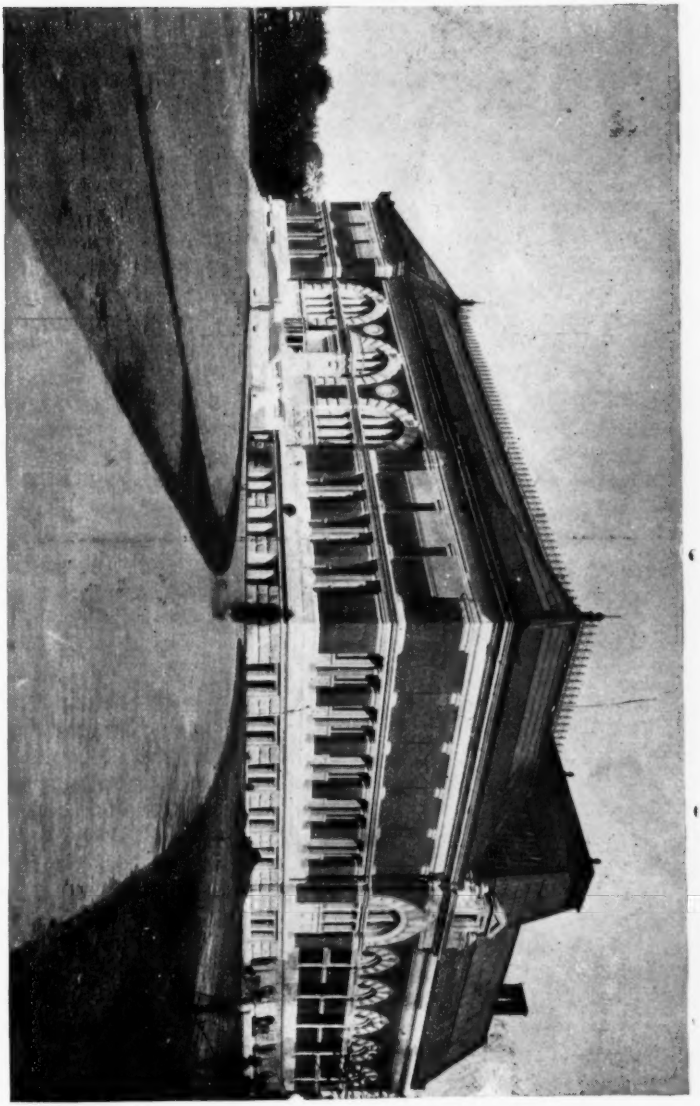


SALLE DES SAISONS, LOUVRE.

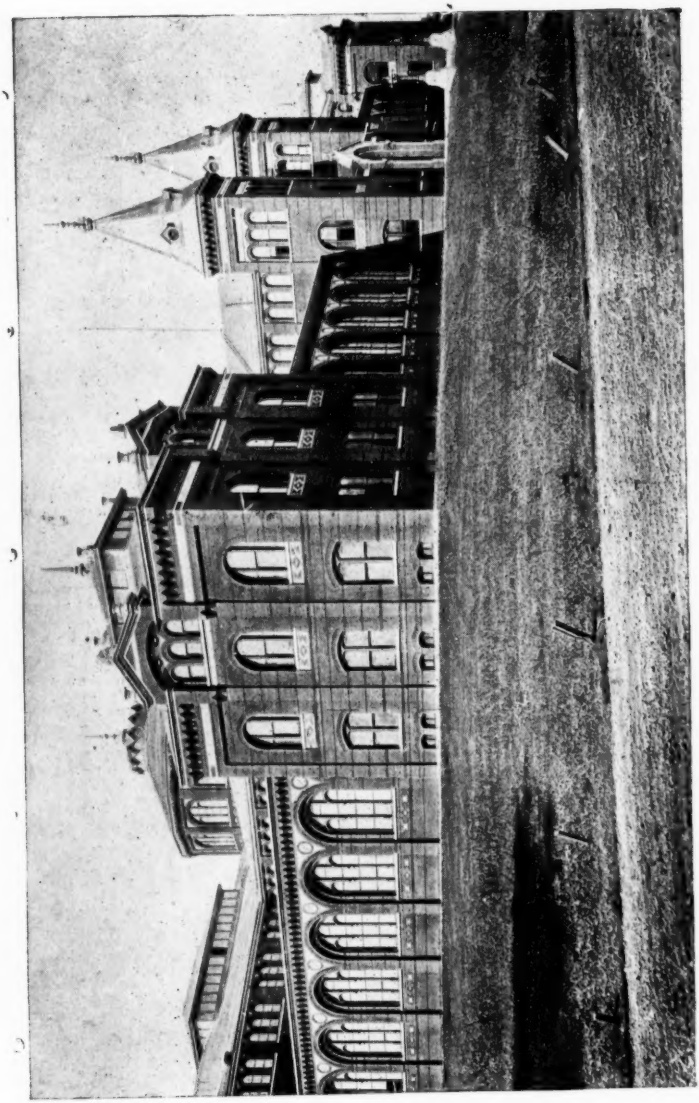
signs, and if the selected one is carried out in its entirety the museum will be architecturally one of the most important buildings in London. The exterior of a building, while generally of the first importance, is not necessarily so in a museum where the plan and arrangement are entitled to first consideration, though when sufficient funds are to be had for this purpose it is a further source of gratification. The objects which form the contents of an art museum are well worthy of being magnificently housed.

In this respect the Louvre is far in advance of any English museum. The British Museum has indeed a portico and colonade of imposing proportions but of no utility and actually harmful to the purposes of the building. Originally, as has been remarked, the Louvre was not intended for a museum, and its splendid halls were decorated in a palatial manner before being put to their present use. This of course gives it an immense superiority over the English museums which were built with a strictly utilitarian end in view. With the rare artistic talent characteristic of the French people every possible advantage has been taken of the interior architecture, and whenever possible the objects have been disposed so as to gain by the rich decorations of the rooms in which they are placed. This is especially so in the magnificent sculpture galleries and the celebrated Apollo Gallery where the works of art are not only artistically and judiciously displayed, but they are arranged to form a part of the architectural features. This system, it is needless to add, is quite exceptionable, but it is one of the most interesting features of the great French museum. The same tasteful skill may be seen in the Musée du Trocadero, though its semicircular halls are by no means well adapted to museum purposes. Another application of the same idea—the artistic arrangement of objects—has lately come into vogue in museums of Natural History, where stuffed birds and animals are shown in their natural habitats. The National Museum at Washington has a group of buffaloes in their native state which is probably the finest in the world as it is the largest of these groups.

Museums at home follow museums abroad very closely in the plan while they necessarily differ in scope and contents. The Metropolitan Museum in New York easily ranks first among American museums, and in some respects its collections equal if they do not surpass the best in the Old World. The Metropolitan is yet too young, and its collections in many cases too incomplete to call for the scientific arrangement to be looked for abroad, yet like all Euro-



METROPOLITAN MUSEUM OF ART, NEW YORK.

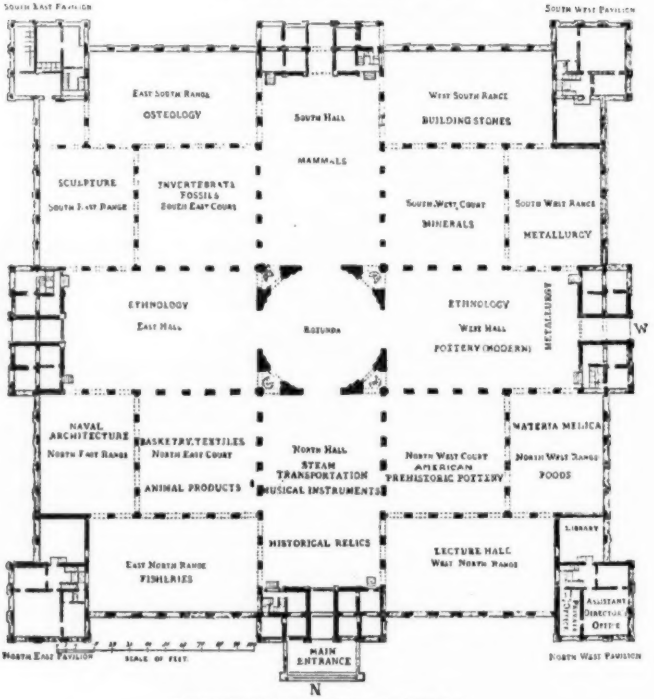


NATIONAL MUSEUM, WASHINGTON.

pean museums it has suffered from lack of accommodations, and the extension of the building has been a difficult problem for the trustees. Already several galleries have been added to the original structure, and a fresh addition—which the accumulations of the next few years will be certain to render insufficient—is under way. It is the typical museum building, with galleries and corridors flanked by small rooms which are rather more numerous than in smaller buildings abroad.

The National Museum at Washington is much more miscellaneous in its character than the Metropolitan, which is exclusively a museum of art. Nineteen departments are already represented in it, including arts, industries, sciences, and all forms of natural science, and it is destined before long to be one of the great museums of the world. London has nineteen distinct museums and Paris thirteen, situated in different parts of the cities and under different control; the authorities of the National Museum hope to establish an institution under one governing body which will do for Washington and thus for the whole country what these distinct museums do for London and Paris. The idea is an excellent one. There is no reason, if the departments are properly subdivided, why such a scheme should not be successful; it would secure a considerable reduction in the cost of administration and will prevent the unnecessary duplication of objects which is unavoidable when a number of institutions have the same end in view. In the National Museum no one system of arrangement can be adopted for the varied departments, the natural history collections, for example, calling for different treatment than that suited for the ethnographic and archæologic objects. In plan the building differs somewhat from the typical museum, being nearly square and divided internally into oblong sections or rooms devoted to different departments.

The ideal art museum—archæological, general, industrial—is that which brings all the products of one people or time together in one place. The visitor to Europe does not spend a day in England, the next in France, the third in Belgium, the fourth back to England, the fifth in France again, and so on, but he exhausts so far as he is able, one country before beginning on another. So in a museum a visitor, even if not a student, gains a better idea of what any one people produced, their manners, their customs, their life, if everything relating to them is conveniently and intelligently arranged together, so that the most varied kinds of work may be compared and a visit to a museum become, as it should and is intended



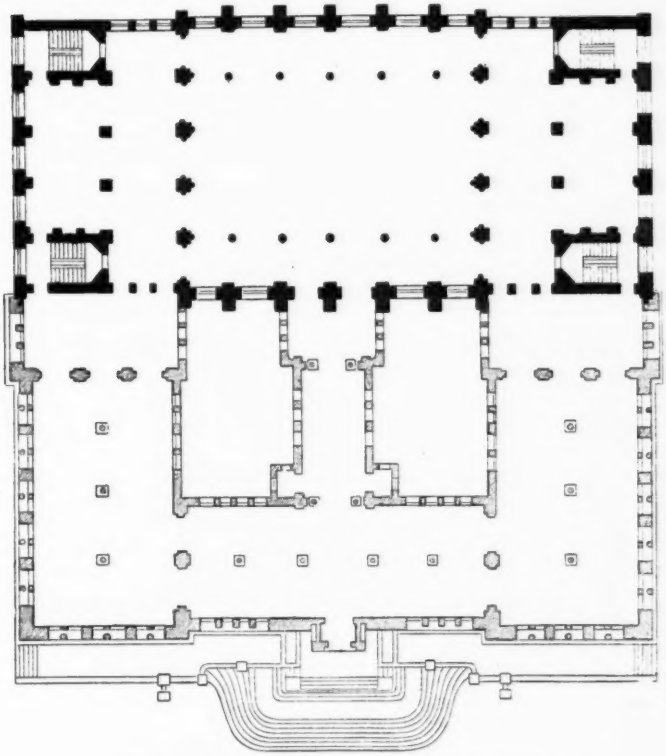

PLAN OF THE NATIONAL MUSEUM, WASHINGTON, D. C.

to be, a source of profit as well as of pleasure. On the other hand it may be equally profitable to study all kinds of one product from all times and peoples. The perfect museum, therefore, would be one in which both these systems would be combined.

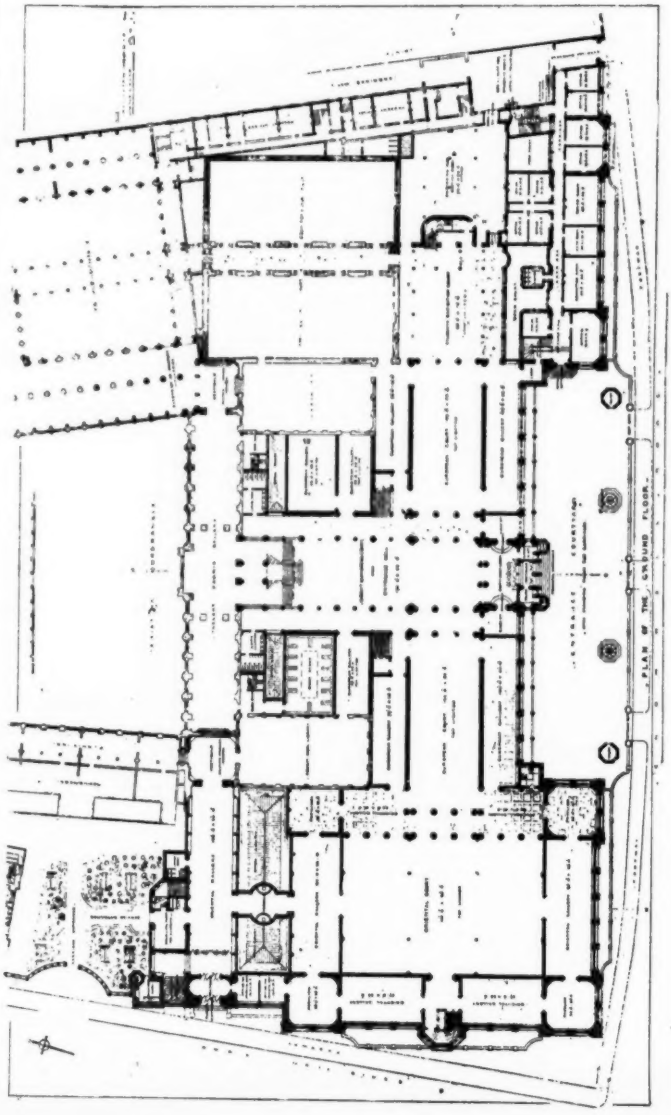
The elliptical building erected for the Paris Exhibition of 1867 is the type of the true museum building. In this structure each nation was assigned a segment so that by advancing from the centre towards the walls the visitor was enabled to study the achievements of each nation in every branch of art and industry, of science and manufactures. As each kind of product was contained within parallel portions of the ellipse it was also possible, in moving around it, to compare the progress made in each particular department. Thus both the comparative and national systems were completely carried out in one building without loss of room and with an economical system of construction. All the essentials

for the proper arrangement of a museum are contained in this plan, and simple as it is, it offers a solution to the difficulties under which the authorities of the great European and American museums have been laboring for years past.

Fig. 1 shows an outline plan for such a building on a circular basis, and Fig. 2 a diagramatic section of the same. It is by no means necessary that it be but a single story in height, and in the diagram several stories have been added which might be further increased. The light wells might, in actual construction, be made smaller than represented in the figure, and the floor space could be increased by means of galleries without too much darkening. An-



FIRST-FLOOR PLAN OF THE METROPOLITAN MUSEUM, NEW YORK.




PLAN OF THE NEW BUILDINGS AT SOUTH KENSINGTON.

other advantage of this plan is that the entire building need not be completed at the beginning, but after the radius has been selected, it could be built a segment at a time, thus permitting very great if not indefinite expansion according as the additions to the museum or the funds in hand permitted. A large site would be required, but not greater than is now used by several European museums. From a critical standpoint a theoretical building has obvious advantages over an actual one, yet the present type of museum building has so many disadvantages, both architecturally and as museums that it cannot be out of place to urge the trial of a new form which obviates some, if not all, of the present difficulties.

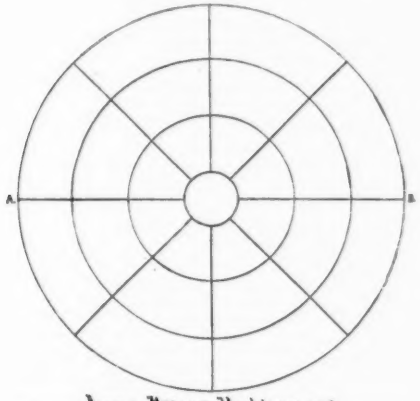



Diagram of Museum Building (Fig 1)

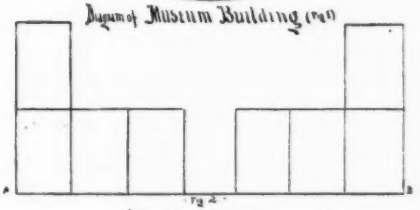



Fig 2.

Section Through AB of Diagram (Fig 1)

# WHAT IS THE USE OF BUILDING LAWS?

## WHEREIN THEY ARE USEFUL—A CRITICISM.

*By Edward Henry.*

IN answering the question raised by Mr. John Beverley Robinson in the August number of THE ENGINEERING MAGAZINE,—What is the Use of a Building Law?—I am free to confess myself one of that very large class, the public, who believe in a building law because there is one, though not as unreasonably or as blindly as Mr. Robinson would have his readers believe is generally the case. The philosophic historian knows no more delightful task than the drawing of generalizations from definitely established data. But the fascination of this pursuit is so great that the generalizer is in danger of forgetting everything else in seeking to extend his science, with the result of propounding laws that rest on too slight foundations to render safe their acceptance as general conclusions. There can be no greater mistake than the taking of broad generalizations as a basis for regulating specific instances. Hence the impropriety of applying the conclusions of Mr. Herbert Spencer on the general inefficacy of laws to the value of the building law in force in New York City. Sound as are the principles Mr. Spencer sets forth it is a mistaken application of them to argue that because some laws are ineffective therefore all must be. It is true enough that the majority is not always right; that the majority may be ignorant and stupid; that safety and learning are not to be found with the multitude. But it must not be inferred from this that it is always wrong, nor is an opinion to be opposed for the simple reason that it is of general acceptance. Mr. Robinson himself probably would reject such an inference carried to its logical conclusion, yet he takes the trouble in opening his argument against a building law to read a lecture upon the uncertainty of majorities, for no other apparent reason than that there is a certain and very general belief in the utility of building laws.

It is not to be denied that there is an ever-growing tendency to elevate the law as law above the suggestions of sense and the dictates

of reason. Religion, morals, ideas, methods of thought, the social fabric itself have been changed in the evolution of society; law remains the solitary fetish of modern life that loses nothing in dignity, renown or power, in the march of the ages. But because law alone remains of the ideals of the past, because it alone has stood the shock of modernity are we to throw it into the cauldron of progress and destroy it as we have already destroyed ancient religious faiths, and as we are now destroying our older system of morality? It is not a sufficient reason for condemning a thing that it is the last of its kind. Antiquity does not diminish the art value of a building or a picture or a piece of sculpture.

Modern life knows too few ideals, recognizes too few merits acknowledges too few precedents for any surviving power of the past to be rudely thrust to one side. Philosophically it may be the height of folly to elect legislatures, make laws and impose penalties, yet in practice this is not true. Our statute-books may be encumbered with unwise, pernicious or useless laws, the product of ignorance and folly, but the mere uselessness of some laws is no argument for the abolition of the whole code. Advanced as the modern state is, society is composed of too diverse elements—unrestrained, unthoughtful, rash elements—for it to exist without some holding influence; not a perfect, capable, always acting influence, for modern society is too much mixed and too unwieldy for that, but an influence that may be generally depended upon in the direction of right and justice. The single influence in modern life that fulfills this function is law. But the merit of the law is not limited by its being a relic of the past. It performs a duty to society apart from any question of age, a duty which gives it a hold upon the regard of the right-minded and upon the fears of evil-doers. No other element is so widespread in its action, or so closely unites all classes of men in the harmonious whole which is termed the nation.

There is thus, I take it, unquestionably a general utility in the law, using that term in its broadest, most unlimited sense. And a substitute must be found before it can be dispensed with. Individual ingenuity, individual influence, individual progress cannot take the place which the law holds in the well-regulated civilized community. In the early history of some of our States there were districts without law where every man was judge, jury and executioner combined. Civilization began in these regions with the introduction of law, and the higher and more refined and complete

the civilization the more perfect and the more elaborate will the law be found to-day. There is, in fact, a direct ratio between the law and society, the more complex the society the more complex the law; the more varied the conditions the more varied the subjects with which the law concerns itself.

Now, admitting the general utility of the law, to what extent shall its scope be limited, or shall it be limited at all? Here it is, doubtless, that Mr. Robinson would take issue, for while he finds occasion to quote Mr. Spencer on the non-utility of laws in general, his special point is the uselessness of the building law, irrespective of the value of laws affecting other things. It is not less difficult to follow him in this than in the more general proposition. The building law may be full of errors and shortcomings, and unpleasant and obnoxious in practice, though the idea of the law, whatever its individual faults, may be wise and good and full of forethought for the people and their safety. No more striking answer to the query, "What is the Use of a Building Law?" could be imagined than the fall of the Taylor Building in Park Place, in New York, which happened almost before the ink had had time to dry on the printed pages of Mr. Robinson's article. The unexpected no sooner happens than every one knows it might have been expected. There seems to be little doubt that if this disaster was not caused by an over-loading of the floors, it was at least hastened by it. Every one knows now that had this building been properly inspected, a great disaster would have been averted, a large financial loss prevented and sixty lives saved. While the fall of the Taylor Building illustrates the need of a building law, it also illustrates one of the deficiences pointed out by Mr. Robinson. This dreadful calamity might have been prevented had the building been duly inspected; but inspection, we are told, is out of the question. Not only is the number of inspectors inadequate for the duties imposed upon them, not only are they themselves sometimes incapable of doing what they have undertaken, not only are they without the means of enforcing the decisions they form from their inspection, but the conditions of modern trade, the rapidity with which buildings are filled and emptied, submitted to strain and released from it renders the work of the inspector valueless. And so, because we live and move, buy and sell, and transact business we do not need to have the stability of our buildings tested, do not need to know how strong or how weak they may be, do not need to know whether lives may be endangered within or without them!

The difficulty of a thing is no excuse for not doing it. The more arduous the task, the larger the reward and the more satisfaction one obtains from one's exertions. Modern science and ingenuity are not baffled by tremendous obstacles, and so simple a question as the variable load of a building offers no reason for the repeal of all building laws. Neither is the insufficiency of inspectors a more potent argument. It may be a costly process to inspect properly all the buildings of a great city like New York, but he would be a rash man who would name the sum that had better have been kept in the city treasury rather than have the high-priced inspection that might have prevented the Park Place disaster.

There is doubtless a large class of subjects with which the law should not concern itself. Laws regulating the details of private and personal existence are not only notorious failures, but these things are admitted generally to be beyond the proper jurisdiction of legal restraint. The unsuccessful history of Prohibition in those States which have incorporated this principle in their laws is too well known to require more than simple mention here. But while questions of private morals may best be left unregulated by law, there is less reason to doubt the efficacy of laws having for their object the public safety and health. They may not always be good laws or wise ones, nor the best that might have been devised, but at foundation they typify the care of the state for the general welfare; they exercise in public life the watchfulness which parents show for their children.

This is the reason for the building law; this its use and its utility. It was not devised for the annoyance of builders or the distraction of architects. It was not meant to create hardships, nor to interpose obstacles in the production of good work. Its object was not to add to the cost of buildings, to limit their artistic qualities, to retard the development of architecture or to render its practice a thing to be avoided. It may provide places for the politician, but what office-creating law does not? It may have rendered it possible for some prejudiced authorities to make trouble for unpliant, unfavored architects and builders. But whatever unwise provisions may be involved at foundation, the law was devised for the public good. It is a misfortune of human nature, whether in a civilized or uncivilized state, that a very large class, in seeking their own gain, are utterly indifferent as to the effect of their operations upon others. The greed for gain, the inextinguishable desire to get the better of one's fellow-men, is so deeply rooted

in the average human breast, that were there no restraint upon actions affecting the general welfare there could be no permanent social fabric. The civilization of Europe in the Middle Ages began with the reign of law in place of the reign of the lawless; when instead of numberless free-acting barons and nobles there was substituted the restraint of a central power, the law, the realm. We have no robber-barons now, no public highwaymen living in castles and dealing with other people and other people's property and rights as they would not themselves be dealt with. The history of building in America, however, abounds with proofs that the class of men who seek their own aggrandizement, totally oblivious of the necessities and just claims of others, have not yet been extinguished. Nor has general honesty reached that point of development where men may always be trusted to do right without being constrained to do it, or without having penalties attached for wrong-doing.

To put it bluntly, we require building laws, if for no other reason than that we have dishonest, wicked builders who think more of putting dollars into their pockets, than they do of the safety of human life, of the comfort and welfare of the community that provides them with the means of gaining a livelihood and security for their own goods and chattels. It is a dreadful thing to say, but not so dreadful as to have it actually exist in such enlightened centres as our great cities. It is needless to specify examples. Mr. Robinson himself does not hesitate to hint broadly of dark tales he might tell were he not restrained—shall I say it?—by professional etiquette. Not only does the history of building in America show the necessity for a building law—the financial loss occasioned by the collapse of ill-built structures, the danger to which they expose life and limb, the menace to health of improperly constructed houses—but the most unobserving critic can imagine how many more dangerous structures would be put up were there no limitations as to what any builder might do.

There is no sounder, wiser or more beneficial provision of the law than that which prohibits the erection of wooden buildings in crowded city limits. It is not to be supposed for a moment that the abolition of these tinder-boxes in the business parts of New York City would have been obtained by voluntary action on the part of owners and builders. It is easy to recognize the value of such a movement, to point out the increased returns to be had from more permanent and more expensive buildings;

all builders and owners are not devoid of wise perceptions nor unable to recognize what would most benefit them. But a city is an agglutination of hybrid elements, wise and unwise, good and bad, careful and careless. Concerted action among thoughtful, far-seeing men may accomplish much good and prevent much harm, but the thoughtless cannot voluntarily be made thoughtful, nor can they of their own free will be brought to work for others' good when they see no benefit to themselves by so doing. In the multitude of elements forming the modern city there will always be found men who would follow what they conceive to be their own good, or convenience, no matter how harmful it might be to the general public. It is human nature to do so, and human nature, while often a delightful study to the philosopher, is quite as often a most undesirable and awkward public property. The law cannot make men wise and considerate, but it may, under proper administration, reduce to a minimum the harm which the selfish and inconsiderate are almost certain to do without reasonable restraint. The building law may not always give us good buildings or safe ones, nor may it be all it should be, but it diminishes the number of dangerous structures and to this extent it makes life safer.

I am arguing for the utility of a building law on general rather than specific grounds. There may be danger in this course, for while a thing may be generally right and desirable its component parts may be such as to render it quite the reverse. But the faults of any code of building laws are no reason for their wholesale abolition. Though the law aims to be perfect, to produce an improved state instead of a bad one, there are few laws which may not be improved upon in the light gained by experience through succeeding generations. The building law of New York was irksome and misunderstood when it first went into effect. It was something new and strange ; it imposed conditions, and defined responsibilities hitherto unknown or exercised to but a limited extent. Limitations comparatively small, which to-day would scarcely be felt, were, when first put into effect, sources of much annoyance. This is still the case in some particulars and some of Mr. Robinson's observations on this point are right and just. But these features call for improvement, not for unwise, promiscuous condemnation.

The building law, like all other experimental laws, is freely open to criticism. It is but an experiment, slowly making its way and gaining fresh and needed improvement from the criticisms it

daily receives in practice. Its present shape is not stationary; it is not something that has come to stay fixed for all time. The law may be the least changeable thing in civilized society, but it is not unsusceptible to fresh conditions. It is not readily altered, it is not subject to the whims of fashion, the caprice of the day, the variable pleasure of the people. It is as deliberate in its movements as it is solemn in purposes. Yet it does not on this account less admirably perform its peculiar functions nor is it the less useful to society. The New York building law of to-day is the product of several changes and additions. Beginning as a separate law in 1860, it has been amended from time to time first because it was imperfect, and then because new conditions of architecture called for it. Both these reasons, Mr. Robinson maintains, are sufficient ground for abolishing the entire code. On the other hand they would seem to afford a basis for its retention.

Architecture is rightly termed an inventive science. The ever-changing and manifold requirements of modern life, its ceaseless activity, its persistent inventiveness are constantly imposing fresh conditions upon the architect which it is the province of his finest skill to solve in the best way. The structural and business requirements of every edifice present quite enough difficulties for the architect without his task being further impeded by artificial legal restraints. Yet, although Mr. Robinson cites the swift change of modern life as an argument against the building law, he points out no instance where it has hindered the progress of architecture nor prevented the latest results of progress from being incorporated in the newest structures. The most advanced, most complete and finest buildings in New York, the *World*, *Times* and Union Trust buildings, the new hotels on Fifth Avenue and many others that might be named—I speak of construction and arrangement, not achitectural effect, which by no means goes hand in hand with constructive progress—have been erected under the present building law. With all its defects, a code that permits the erection of such phenomenal edifices certainly cannot be condemned as a wholly worthless relic of the past.

The building law has, therefore, a real use, and results in good to the community. The law of no city, perhaps, accomplishes all it should, but such utility as such a law possesses will be increased by its extension on present lines, rather than by a withdrawal from the progress already achieved. People are realizing more and more the necessity for stricter building laws, sharper inspection, less

easily evaded penalties for violations. Sanitary science, for example, though it has made wonderful progress in the last few years and has been the subject of some judicious legislation, requires still a much wider application, particularly with respect to old buildings. Fire-escapes and emergency apparatus require much more careful treatment and much more intelligent study than have yet been bestowed upon them. Private dwellings are very generally without means of escape in fires. A few years ago, Philadelphia was horror-stricken at a fire in an ordinary dwelling in which several members of a well-to-do family were burned to death because they could not get away from the building. In all large cities fire escapes—hideous things, the bugbear of the architect—are compulsory, nominally if not actually, upon tenement houses, hotels, factories and all public buildings. Even with the present regulations, a fire in a crowded tenement is a dreadful thing, full of danger and horror, but the tenement supplied with the most insufficient of fire-escapes is far from being the death-trap that many a small dwelling is. The rarity of fires in the dwelling-house districts is simply a fortunate circumstance that has nothing to do with not being prepared for an emergency. Our tall office buildings are supposed to be fireproof and they doubtless are as nearly so as modern means permit, but the fire last year in the Western Union Building in New York showed that they are not incapable of proving dangerous when the flames have once made headway.

It is not my purpose to propose improvements in existing building laws, that being a task for abler hands, but I cannot refrain from pointing out one or two things which will never be bettered by voluntary action and which call for the enforcing power of the law to remedy. The building law is to a great extent supplemented by the regulations of the insurance companies, but these do not all act under one code of rules nor should their requirements perform the functions of public laws which properly have universal action. The state owes a duty to its citizens not less than they to it, and the proper care of the people's interests should not be handed over to corporations, which, however carefully they are managed, however philanthropic their officers, have at best but their own interests and the declaring of dividends at heart. This is their *raison d'etre*, not a constant concern for the public's safety.

Nor because there are corrupt officials in the building office is there a reason for the repeal of a law designed and operating for

the public good. It is perhaps more wicked to tempt than to fall before the devices of the tempter, but the public conscience need not blame itself because its demand for a building law supplies places for officials who sometimes betray their trust and who refuse to perform the duties of their office without being "seen." There is a remedy for such things, a reward for such people that is not to be found in the removal of the law, and it ill becomes those who have personal knowledge of corruption in the building office to call for the law's repeal on broad moral grounds or because they are afraid for the sins of other men. If there is to be a moral argument for or against the building law by all means let it be a sound one resting on a moral basis.

## WHY I OPPOSE BUILDING LAWS.—A REJOINDER.

*By John Beverley Robinson.*

MR. EDWARD HENRY has done me the honor to reply to my former indictment of Building Laws. He is evidently a well-read man—a man of advanced and liberal tendencies, and of an earnest and sympathetic temperament. I congratulate myself upon my adversary.

Mr. Henry states with admirable clearness the grounds of the general confidence in the efficacy of Building Laws, "I am free to confess myself one of that very large class, the public, who believe in a building law because there is one, * * *" Why he should add, "though not as unreasonably or blindly as Mr. Robinson would have us believe," I do not understand. To believe in a building law—notice the creed formula, "I believe in"—because there is one, is hardly to be called other than a blind belief. Although Mr. Henry states the grounds of the public confidence probably with perfect accuracy, he would, I think, on reëxamination revise the statement as applying to himself.

Leaving such criticism of mere words and looking at the substance of his article, I am at a loss to understand how much weight Mr. Henry is willing to grant to general principles. What is the use of laboriously establishing a general principle if we are not to

apply it to the solution of special cases? Or is it Mr. Henry's argument that not enough facts have been collated for the induction yet of a general principle? It was to meet this objection that I quoted Spencer whose insistence upon an array of facts before reaching his conclusions is strongly marked. What validity attaches to the decision of a majority?

"The majority is not always right," says Mr. Henry, and again he says, halting between two opinions, "it must not be inferred that the majority is always wrong." When then is the majority right, and when is it wrong? If the existing state of affairs at any given time were the best possible, an argument that the majority was always right might be sustained. At one time people did think that nothing better was possible than the way they had arranged things. Each obsolete institution has, in its day, been regarded as the *ne plus ultra* of perfection. Much of this feeling survives still, as for instance, in Mr. Henry's naive assertion that he believes in the building law because it exists. We have, however, reached the point of admitting with our intellects, what our hearts often fail to respond to, that better things even than what we have are attainable; that "the latest novelties" may be improvements in social as well as in plumbing arrangements.

In a progressive society opinions must constantly change; the existing general opinion must always be in process of adaptation by the influence of the ideas of some individuals, at first few in number, and only slowly gaining numerical strength. So we may say that it is mathematically demonstrable that in a progressive society the majority is necessarily and invariably wrong, the minority inevitably right, and that at any period one individual is more right than any other, and than all others, if we had but the ability to pick him out from the rest.

It would be bad enough in all conscience if we were ruled by a majority: the actual state of affairs is far worse. Does Mr. Henry really suppose that the members of the Legislature are intelligent and benevolent? Is he infantile enough to imagine that they discuss measures upon the basis of abstract justice? Does he not know that the knock-down arguments are the smallest and meanest political expediencies, or, still worse, conclusive arguments from the powerful, because rich, parties who are demanding privileges through legislation?

The majority of the people is supposed to govern; in point of fact, just as in any college class or literary society, the few who

value the emoluments or honors work to control and do control the nominal majority. The difference is that in the minor societies the officers must do tolerably well, or members drop out and funds vanish: in our political societies a protesting member may secede in spirit, but he is forced to pay all the same.

Admit, for the moment, as I will cheerfully admit, that some laws are made because of a surviving belief in their efficacy, and with the best intentions. Suppose, for instance, as will probably happen, that Mr. Henry's wishes are gratified and that more inspectors are hired and all buildings, even completed ones, are systematically inspected, what will be the result?

After six or eight years some other accident will happen and then the cry will be, as Mr. Henry urges now, that people move in and out so frequently that inspection is useless. "People ought not to be allowed to move without a permit!" Forthwith we shall have laws compelling an inventory and statement of goods and weights and so on, to be filed with the police before anybody can move in or out, and following that, more restrictions, until we reasonably and properly enact that each citizen must have a passport, certifying that he is permitted to exist by the bounty of Mike Flannigan—his mark—Chief of Police and type of the watchful care of the State, viz., the ward caucus, over the unfortunate engineer, architect or literary man who does not know enough to take care of himself. Why not?

Let Mr. Henry understand that the law is not, as he suggests, an interesting curiosity, to be preserved in a glass case and admired along with the Venus Anadyomene and the Parthenon ruin. The law is a regiment with murderous weapons. The law means the rule of force. It is as Mr. Henry in his previous paragraph says, "the solitary fetish of modern life." The law is a survival of the time when it was held that knowledge and ability rested with the few, which is true, and that therefore the few should have power to force the rest to obey them, which is false; and the falsity of which Democracy arose triumphant to demonstrate. That the many should not have power to force the few to obey them is a new truth, to which Democracy is as yet a stranger, and to support which but a few have as yet come forward.

Whoever may be wise it is for him to persuade others that he is so. Power, whether in the hands of one or of many, is sure to be used by those who wield it for their own advantage, regardless of the wishes of the rest, even though ostensibly, perhaps even sin-

cerely, intended for their good. The most severe oppressions have been committed always by those who have been most sincerely benevolent. The Inquisition was a benevolent institution. The present Czar is said to be gentle and well-meaning toward his subjects ; he is certainly not devoid of power : yet witness the misery to which his people have been reduced by the well-meant exertions of their guardians the State functionaries.

Liberty is to be the watchword of the future, as it has been the watchword of the past, through the advancing ages. Though, for the moment, the crowd sees no salvation but in the intensification of law, the time will come when Liberty shall again be adored as the supreme good.

In the hamlet where I live each person who wants a street lamp in front of his house gets it by paying for it. That is freedom. Before long, no doubt, we shall have street lamps forced upon us, and those who might not pay would have their houses sold and be turned out into the street. This is slavery, much to the advantage of those who prefer brilliantly-lighted streets to the welfare of their neighbors. They will have indeed obtained their lamps, but at the expense of others.

To obtain things at the expense of others is held to be a virtue, at the present time, if done in accordance with the rules of the hay-seed and ward-bummer legislature.

All this is known to a few people ; known I judge, to Mr. Henry ; he perhaps does not realize that this knowledge is a possible basis for practical affairs. Few, even of those who read Mill, Spencer, Buckle, Ibsen, Tchernychefsky, and the rest of the advocates of liberty, realize what their teachings lead up to.

No force at all must be the goal toward which we strive ; and at present as little force as possible. That is to say we should use force only as far as we are compelled by others who use force against us.

This at once bars all statute laws save such as are destined to protect against violence. Even for this end statute law is unavailable, simply because it is impossible to define aggression. The old institution of jury trial is far more efficient. But when I say jury trial I do not mean the wretched affair of to-day. The pure jury trial regards the jurors as sovereigns, each with a veto. They are superior to any law. The attempt to limit their function to ascertaining facts is an encroachment by the judges. Not even now could a juror be called in question for refusing to coincide in a

verdict without giving any reason for his refusal. The most that could be done would be the intolerable and tyrannical course of some judges in refusing the verdict and ordering a new trial. In a real trial by jury the lectures and scoldings that are sometimes administered by judges would be out of place.

With such a jury trial the widest opportunity for experiment and improvement in methods would be obtained, while people would use dangerous buildings at their own risk. Only such injury as might be done to passers could be properly taken cognizance of, and only then if malice or criminal carelessness were proved.

We are not entitled to make laws helter-skelter for every object that, in our limited conceptions, seems desirable. How about the people who think the opposite is desirable? If others do not injure us we must not attempt to control them. Even if we must control them by force or perish under their attack, we must remember that it is a bad business at the best, and resorted to only under protest and with full knowledge of its temporary character. Such are the principles which will prevail after the present fetish worship of law subsides.

I have spoken of general principles. One or two specific points I will mention. Mr. Henry speaks of the fire-limit laws as manifestly beneficent. I have already pointed out that manifest beneficence is not a valid ground for a resort to force.

In this particular case, however, fire-limit laws are not usually made for the sake of their beneficence. A city that is already built up with wood never enacts laws compelling people to take down their wooden buildings and rebuild with brick, although that would be quite as beneficent.

The real object of fire-limit laws is to favor speculators. Where there is reason to suppose cities will grow, speculators buy up in advance and have fire-limit laws passed to keep out buildings that would lower the speculative price of their land. They are on just the same plane as the restrictions that are sometimes put into deeds; favorable to those who profit by them, unfavorable to the one who cannot afford to build a brick house. As for the increase in the number of inspectors, if Mr. Henry owns a building and wants it inspected, why doesn't he pay for it himself? Why should he make people who don't want buildings inspected pay for his gratification?

Fire-escapes, too, may be good things for those that want them. Are those who choose to take their chances to be deprived of all responsibility? If they estimate the cost of a fire-escape to be a

inadvisable expenditure; if they should perhaps prefer to donate the money to some church as a more necessary fire-escape, who shall forbid them?

Or, if people are to be compelled to pay for fire-escapes because they are good things, why stop there? Fresh air is a good thing; let us have inspectors who will compel the riddling of every house with pipes and registers and whirligigs. Well-cooked food is an excellent thing. A corps of efficient inspectors should be appointed to enter each house while dinner is in preparing and throw into the street what is not good enough for their fastidious noses; as they now destroy poor venders selling stocks of food.

Mr. Henry's "dishonest and wicked contractor" is but slightly inconvenienced by the building laws; the false security they engender by placing bad work on an equality with good in the general estimation is really a far more active agent to produce poor work, than their literal prohibitions are to prevent it.

An end to it all. There was a time when America led in the march toward freedom. There was a time when a man named Jefferson had much influence; when the principle prevailed that the best government governs least. But now we are in a stampede. Socialism is our goal. Let the State own everything and dole out to us, her servants, our portions,—what we work for, or what we can steal or wheedle her out of, like other slaves. Nothing less is the avowed object of the new Nationalist party and many who sympathize with it.

Each year the province of government extends. Each year the State encroaches on our liberties; and we do not even know that they are encroached upon!—do not even know that the assuagement of our ills is to be looked for in more liberty than in less.

More liberty! We do not even know that we lack liberty, we think that there could be nobody freer than we.

Yet we have gone too far to retreat. Already Europe is pushing us hard. To this young and favored land liberty will again return. Liberty, golden-pinioned, grown to her full strength, shall again lead us to a civilization that the present dreams not of, in comparison with which the present can scarcely be called civilization; when man shall meet man in friendship, not in struggle; when the rifle and the gallows and the jail shall go the way of the sword and the stocks and the rack; when truth and peace shall flourish out of the earth.

# CIVIL ENGINEERING.

THE Opening of the St. Clair Tunnel, which took place on the 19th of September, has been an interesting event, calling forth considerable comment in the engineering papers. The method of using the shields in construction of this tunnel, which was carried out by the engineer, Mr. Hobson, on account of the originality of its application, the success which attended its use, and the magnitude of the work, has had the effect to connect Mr. Hobson's name with the system in a manner which does injustice to the original inventor of this method of tunneling. Mr. Alfred E. Beach, the present editor of the *Scientific American*, was the first to adopt this system of shields and it was employed successfully many years ago in tunneling for a short distance under Broadway, New York, in the construction of the then projected but never completed pneumatic railway wherein the cars were intended to be propelled by the pressure of air behind them in the tunnel. The only paper which we have seen, which, beside ourselves, has called the attention of the public to this fact, is the *Railroad Gazette* which admits that "historical justice requires that this method of tunnel construction should be known as the 'Beach system.'"

The Propulsion of Steamships in some other and better way than by the use of paddles or screws seems to be the dream of a certain class of inventors. Notwithstanding the many failures with various forms and positions of propellers; lateral arrangements of screws to throw water under the stern of a vessel, and divers other inventions, such is the inventive genius of the age and the powerful stimulus imparted to it by modern progress, that this dream may, after all, some day be realized. Meanwhile some of the efforts to this end are so unique that they do not fail to be instructive; generally by indicating lines of invention which are wholly impracticable. Among these is a new scheme invented by a Mr. Mills, residing in Queensland, and well-known there in mining circles. This inventor discards the ancient propeller, and locates his motive power at the bow of the vessel. The propeller is conical in shape, and of great size; that is to say, of size sufficient to drive away all water from the bow of the vessel, its diameter being nearly equal to the beam measurement of the ship. The shaft is carried out at the pointed front of the vessel, and secured to the front and pointed end of the propeller, the latter being hollow. Friction rollers are employed between the rear of the propeller and the portion of the hull against which it bears. The propeller has helical webs projecting from it at right angles to its surface, the inclination of the webs, with reference to the shaft, becoming greater as the diameter of the cone increases. It is stated in foreign journals that Mr. Mills has constructed a model 4 ft. 9 in. in length, 8½ in. in width, and 7 in. deep, with a propeller 11 in. long and 6 in. in diameter, and that this model gave very good results. In speaking of the experiments with this model the Glasgow *Herald* states that Mr. Mills will immediately build a boat 60 ft. in length, with a propeller 10 ft. in diameter, and that he is confident of attaining a very high rate of speed with it.

Another System of Screw Propulsion which appears to contain all the elements of practicability, and which therefore is likely to come into use, has been proposed by Mr. W. Worby Beaumont, an English engineer, who described the system in a paper read by him at the Cardiff meeting of the British Association. This system is a modification of the Bevis propeller, which every engineer will recognize as a feathering propeller that has been successfully used for several years, In this propeller the blades may be set at any desired pitch, as found most efficient for the particular ship to which it is applied, or for the purpose of adapting the propeller to

either high or low power for fast or slow steaming. Mr. Beaumont now proposes to extend the application of the principle in such manner as to reverse the motion of the vessel by the action of the propeller alone, thus avoiding the necessity for reversing-gear on marine engines and thereby greatly simplifying their construction. The ends which may be achieved by the adoption of this system are as follows: Ships may be propelled by screws rotating always in one direction and actuated by non-reversible engines; the reversal of direction of propulsion may be quickly and easily accomplished without excessive strain upon the propeller-shaft or its couplings; the appliances by which this reversal is effected may be used at any time when the engines are running to vary the pitch in order to adapt the screws to the form, trim and condition of the ship, or to meet any sudden emergency requiring prompt action. The general character of the apparatus will be understood by the statement that the change of pitch or reversal of the propellers is affected by a sliding collar on the tail-shaft operated by a hydraulic cylinder and piston, and connected by rods to the blades of the propeller. The hydraulic cylinder and piston (which may be considered as a hydraulic engine) is controlled by a valve admitting water to either side of the piston, the valve being operated either from the engine room or the bridge, as may be desired.

The Use of Compressed Air in Motors for the Propulsion of Street Cars has been made the subject of another attempt by Mr. S. J. Webb, of York, Pa. A description of this motor has been given in the *Street Railway Review*, with illustrations, from which it is gathered that the air tanks are carried beneath the car and charged to a pressure of 480 pounds per square inch. Reserve tanks for long runs are also provided, these being drawn upon in ascending heavy grades. In descending grades, the action of the motor is reversed, and it becomes an air-pump which forces air into the reservoir through check-valves. The general description of the motor and its operation show that it strongly resembles the compressed-air motor invented and constructed by Messrs. Hardie and James, two accomplished Scotch engineers, who, about twelve years ago, came to this country and carried out a series of elaborate experiments on the Second Avenue Railroad in this city; the practical result being a total failure to adapt the system to the requisites of street car propulsion. Those familiar with the progress of street railroading in this city will doubtless remember these experiments, which, at the time, attracted considerable attention.

The Results of Tests of Refrigerating Machinery, recently published in *Engineering* (London), have been challenged as to their value by a correspondent of that paper who signs himself "Consulting Engineer," and who, by his criticisms upon the tests shows that he is quite familiar with the subject. He points out that the range of temperature in the brine to be cooled, as fixed by the test-committee, was from 28° to 23° F. He pertinently asks "for what purpose are such temperatures useful?" and states that, as a matter of fact, the temperatures which all refrigerating machines are expected to give are from 40° to 30° F. when water has to be cooled, as in the case of brewing, and as far below zero as possible when cold storage or ice-making is required;—the usual temperatures being from—15° to—20° F. for these purposes. Then he further points out the fact that it is at these temperatures that all refrigerating machines fall off in efficiency. The temperatures adopted by the committee give no indication of efficiencies of machines when worked at these low temperatures. Such tests, to be of value, should be made at the practical working temperatures of the machines, and with such temperatures of cooling water as are obtainable under ordinary circumstances.

The Use of Liquid Fuel on the English Steamship *Erros* and on the Italian Steamships *Castelfedando* and *Ancona*, has again called the attention of the engineering profession to the possibilities attending the use of such fuel. The most successful use of petroleum as fuel in marine boilers

is, however, stated to have been on the English torpedo-boat *Sunderland*. The employment of this fuel on the *Sunderland* has been in a boiler of the locomotive type having a web bottom and a furnace front arranged to receive oil-burners, of which there are 31. The oil is pumped from the oil tank and discharged into a small cylindrical tank; and it is thence forced, under an air pressure of 35 pounds per square inch, to and through the burners. As the oil leaves the burners it is atomized by jets of air delivered under 40 pounds pressure per square inch. This intimate intermixture of oil and air, which takes place in the process of atomizing, produces the very best condition for combustion; the result being a continuous mass of flame from within a short distance of the furnace mouth to the tube plate. The combustion is so perfect that there is neither smoke nor smell; it is also asserted that not the slightest deposit is formed in the tubes. From all reports it would appear, that in this method of using liquid fuel the question of danger has been nearly surmounted, and that the practicability of the extended use of liquid fuel for marine use is simply dependent upon cost. It is given out that the Italian Government will continue its experiments with liquid fuel on war vessels; and it is further stated that the results already obtained on the Italian ships have been very encouraging. From various sources it is learned that the Peruvian Government is also falling into line with these experiments, and has ordered one of its gun-boats to be fitted up for oil burning.

A New Camel for Raising Sunken Vessels has been invented by Mr. Charles H. Brown, of Port Huron, Mich., and is described in the Detroit *Free Press*. The main features of this device appear from the description to be two pontoons, or water-chambers, with main decks and deck-houses erected upon them, the hulls or water chambers being divided into compartments by partitions connected with each other by conduits provided with valves, and all communicating with a well. This well can be pumped out by means of a pump placed between the decks. Openings in the sides of the hulls admit water to the compartments when the camel is to be sunk, and suitable valves control these openings. The deck-houses are also water compartments and can be used as such when the lift is great and the full lifting power of the camel is required. The engine room is made water-tight so that when the camel is sunk the operation of the engine is not interfered with. Water ballast is employed to keep the hulls level when a vessel is being hoisted. The pontoons being towed over the sunken vessel, the valves are opened, the hulls gradually fill with water and the pontoons sink. If the lift be great, the pontoons can be still further sunk by opening the valves in the deck-houses, so as to partially fill them. The chains are now adjusted beneath the vessel and secured to their adjusted position. When the chains have been properly secured the water is pumped from the holds of the pontoons, and their buoyancy causes them to rise. The valves being open, the water flows out from the deck-houses as the pontoons rise. When the water is entirely pumped from each hull and the full effect of the buoyancy of the pontoons is exerted in lifting it as far as possible, the pontoons are towed into shallow water until the vessel rests upon the ground. The pontoons are separated a sufficient distance to allow the vessel to come between them, and are held in their separated position by means of girders secured in suitable bearings formed upon the main deck.

A New System of Rock Excavation devised and put into practice by Mr. Henry Lobnitz, of Renfrew, Scotland, provides a means for the removal of rocks from channels which it is desired to deepen, without the use of explosives. The rock to be removed is broken by the blows of a heavy weight or ram armed with a steel cone the point of which is driven into the rock, fracturing the latter and breaking it up in a manner analogous to the action of an ice-pick upon a piece of ice. The system has the advantage over blasting that it may be applied without interruption to traffic, which, in many instances, is an important consideration. In fact it was to meet this very

requirement in portions of the Suez Canal that the engineer named devised the system. The parts of the canal which it was desired to enlarge lie between the so-called Bitter Lakes and Suez; and as these parts have rock-bottoms, a floating machine to carry out the scheme of Mr. Lobnitz was constructed on the Clyde, launched, and towed to Port Said. Preliminary experiments were, however, made at a quarry near Edinburgh to test the principle, before risking the construction of the floating machine. In these experiments it was found that rams weighing two tons, falling from a height of about 18 feet, were competent to breaking up something over one-seventh of a cubic yard of rock at each fall. The floating machine has a length of about 180 feet, and a beam of 40 feet. Its depth is about 12 feet, and its draft is a little over 9 feet. It carries five of the steel-pointed rams, which are let fall from heights ranging from about 5 to 20 feet, as occasion may demand. The rams are lifted by chains operated by hydraulic power. These rams are carried by an adjustable frame which can be shifted toward the front or rear, as may be desirable in working. Dredging mechanism raises the broken rock to the surface for its removal. The facts herein stated are collated from an interesting paper originally prepared by Mr. Edwin S. Crawley and read by him before the Engineers Club, Philadelphia. The economical results, as stated by him, are much more favorable to the system than would have been generally anticipated by engineers in advance of practical trials; the cost of the excavation having been brought down, after some practice with the machine, to 84 cents per cubic yard, (exclusive of insurance and depreciation) for a conglomerate of variable character, and 65 cents per cubic yard for hard rock more friable than the conglomerate.

The Engineering Association of the South held its first regular meeting since the summer recess on Thursday evening, Oct. 8, in Nashville, Tenn., in the Cumberland Publishing House, the future headquarters of the Association not yet being ready for occupation. Vice-Pres. W. L. Dudley and Pres. John B. Atkinson presided in turn. The subject of the series of tests of American woods recently inaugurated by the Department of Agriculture and noticed in the department of Architecture in this number was discussed, and the Secretary was instructed to communicate with the Secretary of Agriculture, expressing the interest taken by the Association in this important undertaking, and urging that the necessary appropriation of funds be secured for fully carrying out the series of tests now undertaken. A technical paper of much interest on the "Estimation and Measurement of Earth Work" was then read by Mr. W. B. Ross, of Nashville, Tenn. The paper, after a general analysis of the requirements and difficulties of earthwork estimation, presented a comparison of the several methods now in use for determining volumes, the conclusion being that the method of "averaging and areas" is a more accurate and just measurement of estimation "than the prismoidal method." The author presented for inspection some tables devised by himself for rapidly taking out the volumes of "three level" ground and also exhibited some graphical scales for the same purpose, and to be used in finding the centre of mass of an excavation.

The Great Dam at Austin, Texas, now building across the Colorado River, will, it is said, supply a larger water power than any other dam so far constructed in this country. It crosses the Colorado about two miles above the city, at a point where the river runs between high bluffs and has a rock bottom. The dimensions of the dam are as follows: Length, 1150 feet; height, 60 feet; width at the top, 18 feet. The material of the dam is rubble and stone. Of rubble there will be used 55,000 cubic yards; of granite, 9000 cubic yards, of limestone, 6800 cubic yards. The erection is well under way. A canal will distribute 13,000 horse power to factories, after supplying power for the electric lighting of the city and for driving its electric railways. The cost of the dam exclusive of gate houses will be $465,000. This is a very important hydraulic work. The gate-houses, together with the canal will, it is estimated, also cost $800,000.

# ARCHITECTURE

THE Capacity of Chimney Flues is a matter which, as pointed out in Mr. Allen's article on the Ventilation of Homes and Schools published in our September number, is too frequently unconsidered by architects. At least one flue of sufficient capacity to carry smoke from the furnace of a boiler or heater having a size that can warm the entire space, ought always to enter into the construction of any building in which heat is to be maintained at all. It very frequently becomes desirable in buildings originally intended to be heated in parts by separate stoves or heaters to change the system of heating and warm the entire space by a single boiler or heater. In many cases a search for a suitable chimney flue, reveals the fact that such a contingency was never thought of in the design of the building. This is specially true of the *flat* buildings in this city, and in a large number of cases where steam-heat or hot-water heating have been contemplated from the outset, the chimneys as named in the specifications and indicated on the plans are much too small. In one case which the writer calls to mind, in a flat building designed to be heated by steam, the chimney had a cross-sectional area of only 64 square inches. A computation of the heating surface required to warm the building and the size of boiler needed, showed that a furnace grate area of 648 square inches was demanded. The chimney area was therefore a little less than one-tenth the grate area. In this, as is quite usual in such cases, the building had been erected and the roofing commenced before estimates for the heating were called for. Either steam-heating had to be abandoned, or a new chimney flue erected at a far greater cost than would have been necessary to have built it of the right size in the first place. In another large flat building which had been heated in parts, and which the owner desired to heat by steam there were many flues, each having a cross sectional area of 32 square inches, and the largest flue that could be found, had an area of 36 square inches. To heat the entire building by steam required a flue having an area of 204 square inches, which, at great inconvenience to tenants and cost to the owner, was but accordingly.

Mechanical Ventilation has been applied to stables by the Central Park, North and East River Railroad Company, in New York City. The *Street Railway Journal* for October, in an interview with the manager of the company obtained the statement that "the system is working in the most satisfactory manner," and "that nothing better could be desired." The foul gases are all drawn off at a level with the floor by the action of two fans driven by an engine of 15 H. P. The combined capacity of these fans is 114,900 cubic feet per minute. This air is drawn into about 1500 openings arranged in the building and provided with dampers in such manner that the amount of air taken from each stall is nearly uniform. So far as we are aware this is the first application of mechanical ventilation to a horse-stable. We have no doubt whatever that the system will pay the company in the preservation of the health of its horses; and that, if the epizootic which a few years since proved so serious in the stables of various horse-car companies in this city, should again appear, it will be found, on comparison, that such ventilation is a powerful prophylactic against the disease.

A Series of Government Timber Tests have been inaugurated in the Forestry Division of the Department of Agriculture. The object of these tests will be to complete our knowledge regarding the properties of various kinds of timber, which vary not only with different species, but also vary considerably in the same species when taken from different localities. Mr. B. E. Fernow, Chief of the Division of Forestry, has recently published a statement relating to these tests and their

purpose, in which tests he hopes to establish "an interrelation between quality and conditions of growth." The organization of the investigation comprises a collecting department; a department of mechanical tests; a department of physical and microscopic examination of the test material, and a department of compilation and final discussion of results. Trees of each species are collected from different localities in which their growth is subjected to effects of different soils and different conditions of climate. Five trees of each kind are cut up into logs and disks, and so marked as to indicate the position of each piece in the tree from which it was cut. Four of these trees are selected as representing average growth, and the fifth is the best developed specimen obtainable from the locality. The various tests are made at different stations provided with laboratories suitable for the purpose; care being taken to perfect and insure accuracy of methods, and the written records being supplemented by a series of photographs, wherever the latter may aid in securing accuracy in results. The tests will be assisted by the counsel and co-operation of an Advisory Board appointed by the American Association for the Advancement of Science.

Roof-Hydrants was the subject of a paper recently read before the Convention of Fire Engineers, Springfield, Mass., by Mr. Edward Atkinson, who also contributes a valuable paper to the present number of this magazine upon a cognate subject. After stating "that the last great conflagration in Boston was wholly due to defects in the construction of a great warehouse," he says "the fire marshal was called upon to describe the origin, the cause and the source of the fire," and in doing so "he adopted the very words of the letters" which Mr. Atkinson "had written to the mayor of the city several years before" setting forth the probability of such a result should the fire occur in the building, and the danger to the lives of the firemen that would attend the attempt to extinguish the fire if "that building were permitted to be completed according to the plan." Mr. Atkinson calls attention to the act that in many high buildings, already standing, the upper stories will burn out while the firemen are endeavoring to cope with the fire in lower stories. He cites a recent fire which occurred in Lynn, Mass., in which he asserts that "had not the night been very still there would have been another great conflagration." He points out that the invention and introduction of the water-tower has demonstrated that heavy streams thrown from above are very much more effective than streams thrown from below. He assigns as a reason for this, that when many kinds of combustible materials are burning, as oils, fats or any material which, when heated, generates a combustible gas or vapor, if the water be thrown upon the burning material, the steam, generated from the water by the action of the heat, rises with great velocity, and, in doing so, becomes a vehicle for the conveyance of the inflammable gas, which, being ignited from below, at once carries the fire to the upper parts of the building. When, however, the stream is thrown upon the upper part of the building, the descending water no longer becomes a vehicle for the upshoot of the inflammable gases from below, but wetting and cooling the upper parts of the building fortifies them against the attack of the flames when they ultimately rise. This condition of defense against fire is afforded by roof-hydrants.

A Scheme for Operating Roof-Hydrants is suggested by Mr. Atkinson's very interesting paper. It is adapted for use in the tall buildings which are now so much in vogue, and wherein there is frequently a lack of hydrostatic pressure. Automatic sprinklers have recently come largely into use as a means of protection against fires in their earliest stages. To apply them to tall buildings tanks are often placed on the roofs and filled with water, the arrangement adding largely to the stress upon the roof of the building, and also being expensive. As a substitute for this arrangement tanks might be placed in the basement or sub-cellar, the water being allowed to flow into them directly from the city service-pipes or water-mains. These might be connected by pipes with

compressed air tanks in which a very large volume of air might be condensed under pressure as a means of forcing water when required from the water-tanks through pipes to sprinklers placed in any part of the building. Take as an example a building 300 feet high. The pressure required to raise water to that height would be in round numbers about 150 pounds. Add to this say 30 pounds as the head required for delivering the water with such force as is necessary. We have then a total pressure of 180 pounds. Double this pressure, and the air, when allowed to expand in the water-tank over the surface of the water, in forcing it out through the pipes would displace a volume of water equal to its own volume under the maximum pressure, before the pressure of the air would be reduced sufficiently to lower the head required for efficient delivery at the top of the building. It is now easy with modern mechanical resources to construct air-tanks which will hold air permanently under a pressure of 360 pounds. If it be objected that the air, in expanding, would chill so much as to freeze the water, and thus interfere with the operation of the sprinklers, it will be easy to show mathematically that the amount of heat which could be extracted from water at the ordinary temperatures of basements in buildings before the water could reach the freezing point would be more than sufficient to satisfy the demand for heat in the expanding air. A small air-pump, working for a brief period, would be sufficient to charge the air-tanks and would thus render the apparatus ready for use in any case of emergency. Engineers will readily see how this system could be practically worked out and they may also see some practical objections to it. To the writer it seems, however, that there is no serious impracticability in the application of this method to structures of any height likely to be erected during the existence of the mania for tall building.

Manual and Technical Training of Architects and Engineers was the subject of a very interesting and instructive paper recently read before the Architectural and Engineering Association of Victoria by Mr. B. F. Storer, and published in the *Australasian Builder*. In this paper a point is made, that too little attention is paid to the preliminary education of pupils before their entering upon the study of architecture. Mr. Storer stated that many are in favor of the pupil going to a builder for a few years, but he thinks that in these days the university workshops, technical schools and colleges obviate the necessity for other practical instruction. In these schools the elements of carpentry and plumbing, with practice in these arts as well as the laying of bricks and mortar, building construction and architecture, theoretical and applied mechanics, are all both theoretically and practically taught. Before entering upon the study of architecture the pupil should be a good writer, and a fair arithmetician; that is to say, he should have a knowledge of decimals, fractions, square and cube root and mensuration; and he should be able to deal with simple equations in algebra. He should also have mastered the first three books of Euclid, and he should have a knowledge of practical, plane and solid geometry. To these should be added free-hand drawing, elementary physics, practical mechanics and elementary chemistry. These statements with reference to the preparation needed for the study of architecture or engineering, coming as they do from a professional man of experience, may be a guide to many young men now desiring to prepare themselves for beginning the study of one or other of these professions.

The Designs of the World's Fair Buildings have been made the subject of severe criticism by the *National Builder*, Chicago, which makes the charge that several of them—mentioning especially Machinery Hall—are so commonplace that the work of the architects who designed them "will suffer greatly on comparison with the elegant classic structures which added so much to the French exposition." The paper quoted also predicts much adverse criticism, on the part of foreigners, both "upon the style of various buildings, and the principles involved in their construction." Doubtless such a criticism is to be

expected, and the prophet who predicts it will be sure to see his prophecy fulfilled. But there may be almost the same certainty in predicting much favorable criticism, and as for ourselves we prefer to go upon record as prophesying good, rather than evil. This is no place for an analysis of principles of construction or a minute discussion of details. Our knowledge of the designs spoken of by our esteemed contemporary is, as yet, only such as can be gained from pictures and plans of reduced scale such as are published in the various technical papers. But while we are not prepared to dispute that some of the points made by the *National Builder* are well taken (as for instance, that some of the work already done has been unsubstantial; or that the substitution of the painted clay-preparation for stone in walls originally designed to be of stone) unfortunately compelled by an underestimate of the cost of stone is much to be regretted, we prefer to look on the bright side, and to feel assured that whatever our transatlantic friends may find to criticise in the design and construction of the buildings, they will carry away with them an impression that there is a mighty energy and enterprise in the people of an inland city scarcely half a century old, that could build such houses of entertainment and invite the whole world as guests to a national reception.

"The Love of the House" is a sentiment which has either died out or is lavished upon buildings undeserving of it. This is the charge made against modern civilization by Mr. Ernest Newton, an English architect, in a paper recently read by him before the meeting of the Architectural Association in London. In proof he contrasts the new English house with that of the Elizabethan period, with its "long alley guarded by yew or box"; its "shaded arcade"; its "flower garden"; its "children playing on the terrace." He says: "I can imagine nothing which can give so keen a sense of pleasure as looking at an old English country-house on a summer evening as the sun is setting. Then one can realize best the beauty of color and proportion. The house and the garden seem the very incarnation of the spirit of home; all sounds are hushed, and peace and quiet reign supreme." Then he goes on to contrast this with the modern "mansion" with its "entrance-gate red-hot with paint and gilding"; its "stone piers topped either with lamp-posts or a borrowed crest." The house is apparently intended to advertise the wealth of the owner. "The enormous conservatory is an outward and visible sign that priceless orchids are grown within, and many tropical plants whose names and natures are unknown to any one but the gardener. The windows blink and stare at the sun, and the great sheets of plate glass look like molten brass. The drawing-room is furnished *en suite* in blue or crimson, and he is a bold man who would dare to sit uninvited on any of the gorgeous chairs or sofas. See the garden from the windows: curved paths streaming like ribbons in all directions, manufactured undulations, 'specimen' trees and carpet beds, everything baking in the sunlight, and as neat and trim as three gardeners and a boy can make it. No one can feel that this is homelike. The melancholy thing is that this result is not brought about accidentally; it is all deliberately planned and thought out, and may be taken as expressing exactly the spirit of the age. The owner is proud of it, and so, in a measure is the neighborhood."

The Opening of the Art Schools of the Metropolitan Museum of Art on the 1st October is an event of interest to architects, as the school is to include a class in architecture, designed to afford opportunities for students, for those already employed in architects offices, and beginners, to study the history of architecture, its principles and architectural drawing specially directed to the planning and designing of buildings. Mr. Arthur Lyman Tuckerman has assumed the direction of these schools, as manager. The organization of this department will form an epoch in the history of this institution; it has long been seen to be a necessary complement to the constantly growing and valuable art collections. The museum has been found too small for its various departments; and is now undergoing enlargement.

# ELECTRICITY.

THE Insulation of Carbon Filaments in Electric Glow Lamps by a transparent insulator has been a problem of unusual difficulty. The protecting glass globes or bulbs are now commonly exhausted of air and water vapor till a very high vacuum is produced in them and then hermetically sealed. The process is not only one requiring the most refined appliances for its execution, but is also expensive; the most minute opening, forming a passage from the exterior into the interior of the bulb, allows inflow of exterior air and spoils the lamp. The latter often occurs by a crack in the glass after considerable use. The combustion of the carbon filament immediately follows. The filling of the bulbs with hydro-carbon vapor, as has been done by Mr. Maxim and some others introduces some defects, although it effectually prevents the combustion of the carbon. Mr. Edison has recently obtained a patent for inclosing the filaments in an atmosphere of nitrogen at a definite pressure, his method, as described in his patent specification, being to first produce an air pressure or plenum in the globe sufficient to leave the desired pressure after the oxygen and water have been removed from the interior, and, second, to remove the oxygen and water vapor. To eliminate the oxygen, he connects with the globe a receptacle containing a substance having a sufficiently strong affinity for oxygen to chemically combine with it. Water vapor is absorbed by some substance having a powerful affinity for water. The atmosphere produced in the bulb is thus made to consist of nearly pure nitrogen, the impurities consisting only of the small proportion of carbonic acid gas and the mere traces of some other gases found in ordinary atmospheric air. Hermetically sealing of the globes will, however, be still necessary; as, otherwise, the expansion of the contained gas when the lamps are lighted, alternating with the subsequent contraction when the lamps are extinguished, would ultimately introduce oxygen by the corresponding alternating expulsion of nitrogen and inflow of air. If, however, the exhaustion of the globes can be obviated, this will be an important advance in the art of electric lighting, provided that the atmosphere of nitrogen can be retained unaltered. The use of a gas instead of a vacuum, would probably exact more from dynamos supplying the lights, as the heat of the carbon filaments would not simply be radiated to the globes, but the action of convection would also be set up in the lamps.

The Application of the Electric Light to Fishing Operations seems a logical result of the use of the light in deep-sea exploration, in which glow-lamps are used to attract the deep-sea fauna. The success which attended this application has led to the use of the electric light for industrial fishing. The fact that fishes are attracted to light in the same manner as insects, has long been known; and lights over the surface of water have been used for ages to allure them. The invention of the electric glow-lamp has enabled fishermen to utilize the light below the surface of water. It is stated that when used in connection with nets, the lights are so attractive that the increase of the catch has been found to be enormous; and that in the salmon fisheries, the use of the electric light in connection with nets has increased so much, that restrictive measures will have to be adopted to prevent the extinction of the fish.

The Electrical Executions which were carried out at Sing Sing on the 7th of July, in the present year, have been made the subject of an official report by Drs. McDonald and Ward, since the issue of our last number. So far as the report throws any additional light upon the subject electric shock it is of little value.

The report leaves little doubt that the four men executed became unconscious immediately upon the application of the electric current. The various criticisms which have been indulged in, claiming that this method of execution is cruel and therefore unworthy of the age, are disarmed by this simple statement. The mere facts that the total suspension of the vital functions did not occur until nearly a minute after the first shock was administered, and that some scorching of the skin resulted are matters of very slight importance. It would not add an element of cruelty to such executions if, after the total and final suspension of consciousness, the bodies of the executed should be entirely cremated by the electric current.

Of Thunder the *Electrician* (London) discourses in an article of considerable length printed in its issue for the 4th September. Notwithstanding the phenomenon of thunder is as old as that of rainfall, and notwithstanding that the science of electricity has drawn to the ranks of its devotees the brightest genius and the most powerful minds of the present century, there are still disputed points regarding thunder; the one point of universal agreement being that it is caused by discharges of electricity from cloud to cloud, or between the clouds and the earth. In the first place, as regards the distance at which the most violent thunder can be heard, the author of the article under consideration thinks that four miles is the limit. If this be accepted the report made by the heaviest discharge of lightning must be much less than that produced by the firing of heavy guns, the report of which is heard at much greater distances. A still unexplained phenomenon is the "crackle" which precedes the main report in lightning discharges. The article under review attributes this to minor local discharges, which always occur, although they can be heard only when the discharge is very near. The rumble with which thunder dies away is attributed to cloud reverberations; while the roar immediately following the crackle corresponds to the time occupied by the sound to reach the ear from different parts of the path of the discharge through the air. For example, were this path one mile in length and in a direction away from the observer the sound made by the first action upon the air would reach the ear some seconds prior to that made by the terminal action, and the roar would be heard during the entire interval. The "bang" usually occurs simultaneously with the commencement of the roar; but instances occur in which these phenomena appear to be distinct from each other. Multiple discharges are the most plausible hypothesis for the explanation of this peculiarity. To prove that the mechanical force of lightning discharges is much less than that of artillery, it is alleged that glass in windows is never shattered by thunder, whereas this is a frequent result of the firing of cannon. From this and other reasons it is concluded that, after all, thunder "is a small-scale operation, and as much inferior to the manufactured article, as lightning is for all useful purposes to a 30,000 volt 'rotary current.'"

A New Ballot Vote Counter is the invention of Mr. W. Albert Hosking, recently exhibited at Morley Hall, Regent Street, London. According to *Electricity*, published in London, the invention comprises the use of ballot paper, which resembles in the main that now employed in the English parliament, the chief difference consisting in the introduction of circular voting spaces (with ample margin) to accommodate a circular voting stamp, which the voter places therein. The other features of the invention are: 1. The introduction of a circular voting stamp or label, with a conducting surface, to be placed by the voter within a circular voting space on the ballot paper, in substitution for the pencilled cross now employed; 2. a travelling arrangement of electrodes designed to make contact with the voting stamps when the voting papers are subjected to its operation for the double purpose of enumeration and scrutiny; and 3. an electric indicator screen, on which the names of the candidates are prominently displayed over dial plates attached to clockwork counters, by which record is made of

all electric impulses received through the voting stamps during the process of counting."

The Effect of the Magnetic Field upon Watches has been for a long time a serious annoyance to those who are obliged to come into proximity with dynamos. This occurs when any of the moving parts the watch are constructed of steel. This fact has stimulated a search for alloys which will answer the purpose of steel while resisting the magnetic influence of the dynamo. Among the alloys which have been recommended for the purpose are the following: Mangor, an alloy of manganese and gold; volfar, a mixture of tungsten and gold; woltine, formed of platinum and gold; and cadmine, an alloy in which cadmium is a prominent constituent. Other authorities suggest aror, composed of cadmium and manganese; and manium, an alloy of manganese, platinum, bismuth, and copper. These alloys have been approved by M. Rousaille, President of the Syndical Chamber of Watchmakers, Lyons, France.

"Electroline" is a name given to a liquid used in a new German process for storing electrical energy, known as the "Marx Process." Whether or not this process is a real improvement upon the hitherto-used accumulators, it is interesting, as it substitutes for the storage of energy at the electrodes storage in a liquid which by means of special charging apparatus is made to undergo a chemical change. In this new system it is stated that the charge-electrodes may be of any known conducting material, as carbon, while the discharge electrodes may be of metal. *Invention*, London, describes the apparatus as follows: "A glass vessel is filled with 450 grammes of chloride of iron, 900 grammes of water, and about 500 grammes of hydrochloric acid. After the salt is dissolved, two or three plates (in the latter case two positive and one negative) are placed within the bath without touching, and correspondingly connected to the positive and negative poles of a dynamo. The passage of the current causes a decomposition of the liquid, which turns greenish, then yellow, and finally passes to a yellowish brown. When the liquid will not absorb further energy, the negative plates are removed and then the positive. While the present accumulators only return their charge with the same electrodes, the electroline requires a change of plates, one of metal and one of higher resistance, such as carbon. A plate of very porous carbon on one well pierced with holes is placed between two metal ones—zinc, copper, or iron. If now the circuit is completed an energetic current is given off, while the liquid decomposes, passing by the same series of colors in inverse order."

The Efficiency of Different Telegraph Instruments has been tabulated by *La Lumiere Electrique* from which the following table is extracted:

| Apparatus. | Average number of messages per hour. | Number of operators. | Average number of messages per hour per operator. |
|---|---|---|---|
| Morse | 25 | 2 | 12.5 |
| " (duplex) | 50 | 4 | 12.5 |
| Sounder | 40 | 2 | 20 |
| " (duplex) | 80 | 4 | 20 |
| " (quadruplex) | 160 | 8 | 20 |
| Wheatstone | 100 | 10 | 10 |
| " (duplex) | 200 | 18 | 11 |
| Delaney (quadruplex) | 160 | 8 | 20 |
| Baudot (quadruplex) | 160 | 10 | 16 |
| Hughes | 50 | 4 | 12.5 |

It is necessary to the comprehension of the table that it should be explained that the average length of words is estimated as 7½ letters, and the average length of messages as 20 words.

An Electric Snow-Sweeper, that is to say a snow-sweeper driven by an electric motor, has been put on the market by a manufacturing company in St. Paul, Minn. A feature of this sweeper is, that while the machine is driven along the track of an electric railway by a motor of 30 horse-power, taking its current through the trolley wire, the two sweeping brushes are each driven by an independent motor, and all the three motors are reversible. It is stated that this plow is competent to remove from a track snow having a depth of from 3 to 12 inches, while running at a speed of from four to ten miles per hour. The independent action of the brush-motors, enables them, when necessary, to

be run at a high rate of speed while the plow is moved slowly along the track, and thus to cut away hard, compacted snow, or drifts. It is stated that this machine was thoroughly tested last winter and its effectiveness thereby completely demonstrated.

The Transmission of Power from Lauffen to Frankfort, a distance of about 108 miles, by which means 1100 glow-lamps were supplied with power, the power being derived originally from the water power at Lauffen, and the recovery of useful energy in Frankfort being claimed as about 75% of that expended in Lauffen, has proved the practicability of electrical transmission of power through long distances; and it may be expected that power which has hitherto been considered unavailable, on account of the distance from points at which it can be practically applied, will now be utilized without hesitation. This method of gaining power for use in cities is likely to very largely increase the business of manufacturing turbines. These wheels appear to meet the requirements for driving dynamos better than any other class of wheel, if we except the Pelton wheel, which has also been successfully applied to this purpose.

Swing Bridges, Operated by Electro-motors, is one of the most recent electrical innovations. In Chicago a bridge weighing 800 tons, 240 ft. long and 59 ft. broad, is now worked by an electro-motor, the current being furnished from the station of the Chicago Arc-Light and Power Company. Another smaller bridge is similarly operated in Milwaukee. The application of the electro-motors used for these bridges was made by the Thomson-Houston Company. The operation of the motors is said to be satisfactory in every respect.

A New Application of the Electric Light, doubtless the result of a dearth of threshing machines wherewith to *thresh* the unprecedently large grain crops in the West, this year, has been to supply light whereby threshing can proceed by night, as well as by day, thus doubling the capacity of machines in case of such emergencies. Agricultural papers have stated it to be a fact that there has been much waste of grain during this harvest because it could not be threshed in time; and this simply because there are not enough machines distributed through the grain-producing regions to meet present wants. Our vigorous and ably edited contemporary, *Electricity*, in a recent article, illustrated by an engraving the use of the electric light for threshing operations, and made the sensible suggestion that portable plants specially adapted to this use conld be made profitable in the large grain growing sections; as whatever facilitates a harvest lessens greatly the risks of loss through adverse weather and other causes.

Electrical Transmission of power derived from water wheels is to be carried out at Austin, Texas, at which place a fine large dam is now being constructed to utilize the water of the Colorado River for the generation of power to run an electric lighting plant and electric railways, the surplus, said to be 13,000 horse-power, to be applied to manufacturing purposes. The dam will prove a great impulse to the growth of the city being situated only about two miles above it. The factories will be supplied with water for their wheels through a canal. The cost of the dam with its gates and canal, is estimated at $1,265,000.

A System of Electric Lighting for Charlotte, N. C., as well as a system of power transmission, the power to be derived from the Catawba River, some miles from that city, has been projected. At Horseshoe Bend, in this river, the current runs rapidly, and there is a point where the banks are only two miles apart. From this point it is proposed to obtain the water power to be converted into electricity for the supply of Charlotte with light and power. The amount of power available is said to be enormous, and sufficient to supply the city, no matter what may be its future growth.

The Display of Electrical Appliances at the World's Fair in Chicago is likely to be very complete. Mr. Dredge, the editor of *Engineering* (London), is doing his utmost to further the the completeness of the English exhibit. Both England and Germany have asked for 20,000 square feet of space, and Chief Barrett has assured both governments that he will use every effort to secure for them the space desired.

# MINING AND METALLURGY.

THE Le Chatelier Pyrometer is beginning to attract considerable attention, it having been found to be not only an extremely ingenious but a very practical instrument for the determining of high temperatures, as in smelting furnaces, brick kilns, in the manufacture of pottery, etc. In an article written by Mr. Joseph Struthers and printed in the *School of Mines Quarterly*, the principle upon which this pyrometer is constructed is stated to be "that the current of electricity produced by heating a thermo-electric couple is proportional to the temperature to which it is heated: "The thermo-electric couple consists of two wires, one of pure platinum and the other of platinum alloyed with 10% of rhodium, joined at one end. Conducting wires transmit the current from this couple to a convenient point outside the furnace, where it is measured by a galvanometer. The wires of the couple are joined by soldering, by simple twisting or forging. Their thermo-electric properties are not altered by hammering and the couple can be heated for its entire length without producing the opposite electrical current caused by the heating of the solder or weld. These qualities make repairs easy in case of rupture." Mr. Struthers illustrates the use of the instrument by a description of the operation of taking the temperature of an open-hearth furnace. In this application of the instrument "the wires may be placed in an iron tube 12 or 10 feet long, with its end luted with clay and the wires projecting an inch or more." Only a few seconds' exposure is necessary and the wires may be variously supported according to the nature of the furnace or kiln in which temperatures are desired to be taken and the number of observations required. Mr. Struthers says that "the manipulation of the instrument requires some care, * * * but is within the reach of any one capable of making a fine reading." The indications of the galvanometer are interpreted from a graphic chart which is drawn by first locating the points representing the "heating of the couples to known temperatures as the boiling point of mercury, the melting point of silver," etc., the extended scale being constructed from these points. The accuracy of the portable form of the instrument in ordinary use is stated by Mr. Struthers to be "such that the indications are never more than 25 centigrade degrees in error, and considerable greater accuracy is obtainable with the fixed instruments."

Exports of Copper from Japan increased largely last year, being more than three times the amount of the exports for 1889, and more than two and a half times as much as the shipments for 1888. The increase for 1890 is attributed partly to the fact that a portion of the exports for 1888 was held over from the previous year. The output of the mines has, however, increased.

The Nickel Deposits of New Caledonia are said to be immense, the area comprising 2,000,000 square kilometers, and including about 800,000 square kilometers of nickel-producing land. Of this it is said that 80,000 square kilometers have been granted to or applied for by mining companies, and that 20,000 square kilometers are now being worked; the mines in operation being those most easily reached by sea or river navigation. Other and richer deposits remain unworked, simply for lack of railway facilities.

Caucasian Petroleum differs from American petroleum in that it contains a much smaller proportion of kerosene or safe-burning oil. It is stated that the best grades of Pennsylvania petroleum yield nearly twice as much lighting oil as Baku petroleum. In order to obtain from the latter a sufficient supply of oil fit for lighting purposes, Russian refiners have been obliged to make a great deal of refuse This refuse has now been applied to steam

navigation on the Caspian and Volga Rivers and on Caucasian and Central Asian Railways, to such an extent that the demand for what was formerly a cheap by-product has increased its value to eight times its former price. For this reason it is not probable that Russian refiners will endeavor to produce any greater output of high grade burning kerosene.

Absolutely Pure Gold is generally regarded as easy to be obtained. However, in an article contributed to the *Journal of the Society of Arts* by Mr. Arthur Wingham, entitled "The Mint of Hindustan in the 16th Century," the author quotes Prof. Roberts Austen as authority for the statement that "absolutely pure gold is seldom or never seen," notwithstanding all our improved methods of refining. Professor Austen is further quoted as saying "that only after a most complicated process of purification did he obtain gold of a fineness of 999.96." Mr. Wingham points out that the processes by which the Hindus obtained their so-called fine gold 300 years ago, would be incompetent to give gold of a fineness exceeding 0.99. But, as at the period named, scientific chemistry was unknown, it is remarkable that they reached even this degree of fineness. Their method of assaying was that of touch-needles, still in use, and they carried this method to a degree of perfection much beyond that of the method as now practised by jewellers and dealers in old gold. This system may not be familiar to the general reader. There are at present in use a series of 24 touch-needles made of gold varying in degrees of fineness from zero fineness or base metal to fine gold through 24 regular intervals of 41.666 degrees of fineness to 1000 degrees or fine. In testing the fineness of gold by the use of these needles, they are separately rubbed upon the surface of a fine grained stone, called a "touch-stone," until a coating of the metal in the form of a narrow streak has been formed on the surface. The sample of gold to be tested is then also rubbed on the touch-stone until it forms a metallic streak by the side of the first streak. With the ancients a comparison of the colors of the streaks was the basis for a determination of the fineness; but in modern times additional tests are made with strong nitric acid, and nitric acid containing a little free chlorine which is obtained by adding to the acid a little common salt, or a little hydrochloric acid. The finer the gold, the more readily the metallic streaks are dissolved from the surface of the stone. Thus, if the streak formed by the needle "holds up" under the acid better than the streak formed by the specimen, the latter is less fine than the needle. It is therefore possible to determine the fineness as being between that of any two of the needles. While the Hindus in the 16th century could, so far as known, only go by color, they made and used sets of touch-needles differing in fineness by only 15.666 degrees, and it is very probable that they were able to approximate the fineness very closely, that is to say, within one per cent. in alloys of gold containing copper, or silver or both. Since the discovery of aluminium, platinum and other metals of which the ancients are supposed to have known nothing, and with which gold may be alloyed, the touch-needle method of assay is subject to error; yet those expert in this method generally arrive at a very fair estimate of the fineness of gold, and are seldom much deceived.

An Appafatus for Testing Safety Lamps described by Prof. F. Clowes before the Chemical Science Section of the British Association at its last meeting, was used by him in the examination of the relative merits of one or two safety lamps as indicators of fire-damp in mines and was improvised for the purpose. He made his tests with marsh gas instead of fire-damp. The apparatus consisted of a wooden box with an inlet tube for gas at the top and an outlet for air at the bottom. Underneath was an opening through which lamps could be introduced for experiment. A mixture of 1, 2, or 3 per cent. could be made, and they could test three, four, or five lamps, one with another, without the composition of air and gas being appreciably affected. The capacity of the box was 950 metres. Prof. Clowes said with reference to the common belief that the Davy lamp would detect 3% of gas that he had

never been able to do that; nor often to succeed in doing it with any of the newer lamps. He spoke in high terms of the Ashworth's Hepplewhite-Grey lamp which burns benzoline through a sponge. He asserted that this lamp gives a capital light and that it has the great advantage that by a very delicate arrangement the flame can be lowered until it assumes the character of the Bunsen-burner flame. When the flame has been thus adjusted, the cap can be seen without such interference as is experienced from the bright flame of the ordinary oil lamp. Prof. Clowes asserts that nothing but the benzoline lamp will give that flame. This lamp has another feature, to wit, the frosting of the glass; so that when the light is lowered it can be held in such a position that the cap can be seen above the frosting, whilst the flame of the lamp is hidden. In testing this lamp with reference to the presence of benzoline vapor, Prof. Clowes found that he could detect one-quarter of one per cent.; and he illustrated his paper with an experiment in which he demonstrated the great delicacy of this test. In the discussion which followed the reading of Prof. Clowes' paper it was brought out that the tests were not made to determine the safety of the lamps, but simply to determine their delicacy in determining the presence of fire-damp. With regard to the objection that in the use of this lamp in mines it might meet currents which would operate upon it unfavorably, Prof. Clowes said that the lamps tested by him were indifferent to currents.

A very Singular Form of Metallic Iron is found on St. Joseph Island, Lake Huron, of which deposit a scientific examination has been made by Mr. C. G. Hoffman of the staff of the Canadian Geological and Natural History Survey. The iron is described as appearing in spherules disseminated through a thin deposit of dark reddish-brown limonite which coat certain faces of some surface specimens of quartz. These metallic-looking spherules were found to consist of nuclei of silicon coated with a humus-like substance, which in turn was overlaid by a metallic layer containing all the elements most frequently met with in meteoric iron. The small proportion of nickel contained in this iron has, however, disposed Mr. Hoffman to regard this iron as possibly of terrestrial origin. Another reason for this belief is the fact that the spherules contain nuclei of a concrete character, so that, on the whole, Mr. Hoffman thinks the peculiar form of the iron may have been produced from the reaction of an iron salt by chemical reaction with organic matter.

The Exhaustion of the Coal-Deposits in the United States will, according to Mr. I. J. Wistar (who has contributed an article on the subject to the *Evening Post*), be reached in one hundred years from the present date (at least approximately) provided the present rate of increase in consumption is maintained. He says that "if we assume that the United States contain —including all tertiary and other deposits posterior to those of the carboniferous period—150,000 square miles, or 96,000,000 acres of coal territory on which the minable coal, ranging from one to sixty feet in thickness, averages eight feet throughout, the entire tonnage of removable coal would be about 768,000 million tons, which is probably a large over-estimate. Taking the present annual production at 130 million tons, with an annual compounding increase of 10 per cent. (the actual rate) for the next twenty-five years; of 5 per cent. for the next fifty years thereafter; and of 3 per cent. for the twenty-five years following, the aggregate consumption by the end of one hundred years, *i. e.*, by A. D. 1991, will have been 849,000 million tons, a quantity exceeding or at least approaching exhaustion." The growing use of electricity and water gas are referred to by Mr. Wistar as tending to hasten the exhaustion of natural sources of fuel; since these are obtained by the combustion of such fuel and the power obtained from them is less than that gained from the direct application of the heat of combustion.

Of the Census Figures, the only thing which appears to be entirely reliable is the cost of them,—thus far amounting to about $8,000,000. By the expenditure of this large sum, there has been collated a

variety of statistics having unreliability as their chief characteristic. The evidence of this truth is constantly accumulating. On various occasions, glaring inconsistencies and erroneous statements have been pointed out in this magazine; and now another is added relating to the copper output for 1889. The *Engineering and Mining Journal* is the highest authority in this country on this subject. That journal as is widely known, obtained official returns from all the copper producers in 1889; and now, a comparison of the work of the census bureau with these returns, shows, in so far as it relates to this important industry, that the work is utterly worthless. Only in the Lake Superior District do the census figures agree with the official returns collected by our contemporary. California is stated to have produced less than one-tenth its actual output. Neither Utah nor Colorado has been credited with anything like its actual output. Our contemporary closes its caustic editorial with the following criticism:

"The total expenditures for the production of copper in the four States of Michigan, Montana, Arizona and New Mexico are put down at $12,062,180, or about 5.4 cents per pound of copper. How surprised the impatient stockholders of several producing companies must be to learn that the average cost of producing copper was only 5.4 cents per pound, and how they must wonder at their balance sheets and their modest dividends or occasional assessments! Their experience will scarcely allow them to believe this item of the census statistics. Every one indeed, knows that it is very far from correct. The labor statistics are also open to criticism, but it is not our intention to do more than indicate a few of the most important points, and to express our great regret that the census statistics of the great lead and copper industries should have been treated in so disappointing a manner."

The manner in which the census has been conducted and the worthlessness of the results must long remain a deep humiliation to every true American.

Samples of Mica from the Girard Mine owned by Thomas J. Walters, of Ottawa, Canada, are said to have formed one of the most interesting of the exhibits at the recent Electrical Exhibition at Montreal. Both on account of the size of the cut sheets—some of which were 10x13 inches—and the quality, which is excellent, as well as the productiveness of the mine from which the mica is obtained, this exhibit was viewed with interest. The mine is of quite recent discovery, having been first opened in the fall of 1890; so that it is little more than a year since its product has been put on the market; yet it already ranks as the most valuable mica deposit so far found on this continent. Its weekly output of rough mica is stated to be 12½ tons; about a ton of cut mica per week being produced. The first 120 tons taken from the mine was sold to the purchasing agent of the Thomson-Houston Company.

Labors of Metallurgists, according to Prof. Roberts Austen, President of the Chemical Section of the British Association, have been more influential in adding to industrial and chemical knowledge than the investigations of any other class of scientific workers. This statement was substantially made in his address at the recent meeting of the Association at Cardiff. He added that "in no other art have the relations between theory and practice been so close and enduring." Though Prof. Austen did not assign this closeness of relation between theory and practice as the secret of the value of metallurgical research, this will suggest itself to all who have been students of the history of scientific progress. In speaking of the history of metallurgy in particular, especially in the British Islands, Prof. Austen said that "it would seem that the two classes of workers, the interpreters of nature and the practical men, have for centuries sat in joint committee, and, by bringing theoretical speculations into close connection with hard industrial facts, 'have carried us nearer to the essence of truth.'" The essence of truth would have been a happy phrase if Prof. Austen had used it in another sense,—the benefit which practical men derive from scientific research, in seeking out and applying scientific truth, in the useful arts, to the practical purposes of civilized life. In this way science and the useful arts mutually advance, each furnishing new material for research.

# MECHANICS

THE Prevention of Corrosion in Boilers by the use of zinc, formed the subject of a discussion at a recent meeting of the British Institute of Marine Engineers. The proper amount of zinc required to each square foot of grate was considered to be about four or five pounds; and this zinc should not only be placed in the water space, but also in the steam space. It was further stated that a paint of zinc-white applied in the steam space will prevent corrosion. The view of the cause of corrosion taken in the discussion was that corrosion is due to electric action. The application of the zinc protects the boiler on the same principle that zinc attached to the copper bottoms of ships prevents the detrimental action of salt water upon them.

A New Clutch which has been introduced abroad is certainly one of the most unique inventions recently put upon the market. It is called "Snyer's Bristle-Clutch," being named after its inventor. This clutch consists of two parts, one of which is keyed to the end of a piece of shafting; the other slides upon the correlated end of another piece of shafting to be coupled to the first named. The two counterparts of the clutch are disk-shaped; that part which is keyed fast has, on its flat face, a series of projecting fins or teeth much resembling the teeth of a crown-wheel. The other disk has projecting from its face a series of what the inventor calls bristles, but which are in reality short, stiff wires tempered and highly elastic. When that part of the shaft to which the finned disk is keyed is revolving rapidly, (the other part of the clutch being splined to its shaft after the usual manner) if the latter be pressed against the finned disk, the short elastic wires engage the fins and become springs. The sum total of their combined elasticity is sufficient to drive the shaft; at the same time the coupling is effected without shock or appreciable noise. Another effect of the clutch is, that if the shaft to which the finned disk is keyed acts as a driver, communicating motion to the other part, the elasticity of the bristles is sufficient to compensate for pulsations in the driving motion. Moreover, if a sudden accession of speed be applied, the clutch, instead of driving, slips and prevents trouble which might otherwise arise from communication of the increased speed, as in the case of dynamos. It is stated that several of these clutches have been employed for driving dynamos in Germany, and that irregular pulsations are so entirely absorbed by the clutch that they do not in the least affect the steadiness of the light.

A New Wreck Indicator has been brought out by Mr. A. F. Ward, of the Frontier Iron Works, Detroit, Michigan. It is an ingenious device. A detachable hollow ball consisting of two united hemispheres is placed upon the top of the pilot-house, and is there attached by a soluble glue joint, this joint being, however, not so soluble that it immediately detaches upon the submergence of the vessel. Its composition may be varied so that it may be made to detach under the action of water anywhere from 24 to 48 hours after the vessel has been sunk. Within this ball is a reel upon which is wound a cord (or, when used in salt water, a copper wire), and one end of the cord is permanently attached to the top of the pilot-house. The reel is so arranged, that when the ball, after detaching, floats to the surface of the water, the reel is automatically locked, so that the cord or wire can no longer unwind. Thus the buoy marks permanently the place where the vessel may be found. It is well known that great expense is often entailed in the search for sunken vessels, and it would seem that this simple and inexpensive device would meet with favor. The *Marine Review* states, that in response to an invitation, a number of vessel owners and others recently met at the Wayne Hotel, Detroit,

to examine this invention, and it was viewed so favorably that there is little doubt of its general adoption by the Lake Marine within a few years.

A Neat Device is an Improved Brush for Cleaning Ship's Decks, which has just been brought out by Mr. John Laidlaw, of Glasgow, Scotland. The handle of the brush is not unlike the handle of a hoe, is hollow, and, to the end opposite the brush, a hose is attached through which water may be constantly delivered to the brush from the deck-pump. To the end of the handle opposite that to which the hose is attached, is connected a casing in which there is a small turbine; and to the shaft of this turbine is attached a revolving brush. The forcing of the water through the hose and through the handle not only supplies a constant stream of pure water to the brush, but, at the same time, causes it to rapidly revolve. We consider this a very ingenious invention, and have no doubt as to its practical utility.

Mr. Edison's Magnetic Driving Belt, which consists of a number of steel wire ropes, strung with cross-bars of soft iron, would seem to be an entirely impracticable invention, unless it is intended to apply it to very slow moving wheels. Wheels rapidly rotating with this belt upon them would create in the cross-bars such an amount of centrifugal force as would practically overcome the magnetic attraction of the wheels for the bars, the wheels being designed to be made strongly magnetic by windings of insulated wire after the manner of armatures in dynamos.

The Danger of Spreading Fire by throwing water upon burning oil, oily waste and analogous materials is very impressively set forth by Mr. Edward Atkinson in a paper read by him before the Convention of Fire Engineers, Springfield, Mass., which paper we have also quoted to some extent in our Department of Architecture in this number. When oil or cotton waste takes fire in shops one of the first impulses is to throw water upon it. The points brought out by Mr. Atkinson are of importance to all mechanics. He says that one of the largest losses which the insurance company of which he is president was ever called upon to pay was mainly caused by the misuse of a bucket of water. He describes the occurrence as follows:

"In the early evening a mechanic, who was working alone after mill hours near the main gears, dropped his lantern in the slush box, setting fire to the grease and lint collected therein. It burned with dense smoke and very little flame. Two or three shovels of sand or a wet blanket would have put it out. But he did what he supposed was the right thing—he threw a bucket of water upon the burning grease. Instantly a fierce flame sprang up to the very ceiling of the basement, passing through the belt holes, setting the mill on fire, which was completely destroyed. I was not then an officer of an insurance company, and I did not at that time take up the subject for investigation. A little later I happened to go to my seaside house with my boys in the early spring. I had not then invented the Aladdin oven, and we undertook to fry some fish on the top of the cooking stove; not being very skilful, we set the fat on fire. I took a dipper and poured some water into the burning fat. Straightway another great flash of flame roared up, singing my hair and whiskers and reaching the ceiling of the kitchen. I then recalled the incidents of the mill fire, and determined to find out what it all meant."

Mr. Atkinson then consulted Prof. Ordway of the Massachusetts Institute of Technology, who explained that steam combines with and takes up other gases, its own volume lifting or raising them, thus becoming a carrier of combustible vapor and flame to anything combustible situated over the fire. The best thing to extinguish burning fats or oils or oily waste is sand; and it would be a prudent thing to have buckets of this material standing in shops where flames of this character are liable to originate.

A New Steam Jet Exhauster, designed to render the waste of steam less than with ordinary jet exhausters, has been brought out in England, the increased efficiency of the jet being due to the greater surface of the air brought into contact with the jet. As described in *Engineering*, (London), "the steam issues radially between two disks fixed at the end of the steam pipe. Openings through these disks lead into branches connected with the suction pipe through which the air is drawn. The thin

radial stream of steam in flowing over these openings takes up its full quota of air, and the manufacturers claim that a very considerable saving of steam is effected. The thickness of the jet is regulated by the hand-wheel, the spindle of which is attached to the lower disk. The best distance between these disks is found to be $\frac{1}{100}$ in. to $\frac{1}{80}$ in. The exhauster works with a complete absence of noise. Though primarily designed for exhausting air for sand blast purposes, the apparatus is evidently applicable elsewhere."

A New Patent Pipe-and-Bar-Bender devised by an English inventor and now being manufactured and put on the market by a manufacturing firm in Sheffield, is an extremely ingenious and handy tool. This apparatus will bend pipes and bars of any section without kinking or flattening them. The bed-plate may be fastened on any improvised bench by four screws. On the bed-plate is an upwardly projecting journal, and in line with this journal is a slot in which a stud or burr may be adjusted at any distance from the centre of the journal. The moving part of the apparatus consists of a lever with a bifurcated end, in which are fitted one large bending wheel and another smaller bending wheel, these wheels being grooved so that when their perimeters are brought together they exactly fit the pipe or bar to be bent. The wheels are interchangeable for other wheels in bending different sizes of bars or pipes. The large bending wheel is passed over the upwardly projecting journal in the bed-plate, this journal not only passing through the wheel, but through the counter-parts of the bifurcated end of the lever. The smaller wheel is journaled through these two counter-parts by a pin which may be adjusted to different distances when the large wheel is interchanged. The lever being turned around so as to abut against the stud or burr, the pipe or bar to be bent is passed through between the two wheels. The lever being then turned to a position at right angles with that which it occupied when the pipe or bar was inserted, a right-angled bend will be made. It is stated that a pipe so bent, without filling, is as smooth as any which can be obtained in the market and that the operation of bending occupies only a few seconds. Moreover, a pipe may be bent successfully in opposite directions, thus saving fittings in making off-sets. The practical value of this last feature will be at once apparent to steam fitters.

The Soldering of Iron with Nickel has been accomplished by Herr Fleitmann, whose experiments have yielded what may prove to be important results. These results have been described in *Iron* (London) which states that the adhesion of the two metals rendered it impossible to separate them by mechanical action, a perfect assimilation taking place at temperatures as low as even 500° to 600° under the point of fusion. An interesting result of the superposition of the metals and then heating them to a degree less than required for their adherence is that the iron is found to penetrate the nickel to a considerable distance. This is held to establish the volatility of iron at a cherry-red heat. It is said that, in this experiment, "on the whole surface of the sheet of nickel an alloy with the iron was formed, which, in the case of one millimetre sheets, penetrated to 0.05 of their thickness, and contained on the average 24% of that metal, the proportion being naturally stronger on the surface. An important fact is that the passage of the iron to the nickel is not reciprocal. While the combination disclosed itself on the surface of the nickel plate by the argentiferous lustre of an alloy of iron with nickel, the iron plate remained intact, and preserved the sombre appearance which it had received from the scaling."

The Red Stains on Birmingham (England) Copper and Brass, as seen on buttons, cartridges, etc., have been made the subject of investigation, and they are found to be caused neither by any imperfection in the metal nor by the action of numerous causes erroneously assigned for them by the workmen employed in manufacturing such articles; among which causes may be enumerated burning; presence of sulphur; furnace-dust and dirt, contact with the iron poker, etc. Mr. Turner, a member of the British Associa-

tion, explained to the Chemical Section at its late meeting that these spots are merely superficial—not extending deeply into the metal as also supposed by the workmen—and that they are caused by the water used to wash the articles after *pickling* them, through the action of chlorides contained in the water. Mr. Turner states that the Birmingham water was well known to contain chlorides, and the experiments described in this paper traced the spots to their action as the sufficient and only cause of the spots. It is stated that manufacturers have sustained considerable losses from this spotting of their goods, which may be avoided by thoroughly wiping off the water from the metal surfaces, after washing, instead of permitting the water to evaporate therefrom.

A New Flux for Welding is announced as having been brought out and used in Germany, and it is claimed "to be excellent." Its composition is, however, so simple, and its application so easy that any mechanic may easily test its merits by a practical experiment. As described, "it consists of borax, 50 per cent.; sal ammoniac, 25 per cent., and water, 25 per cent. This mixture is boiled, being at the same time continuously stirred until it is reduced to a stiff mass, which is then held over a fire until it becomes hard. When cold, the mixture is well pulverized and assimilated with one-third part of rust-free wrought-iron filings. The pieces to be welded are first dovetailed, or otherwise connected; the welding parts are then heated to redness, when the powder is strewn over them and allowed to liquefy over the fire. Only very slight blows are then required to consummate the perfect conjunction of the pieces."

To Impart a Gold Color to Soft Solder the following method is said to be good: First prepare a saturated solution of sulphate of copper—bluestone—in water, and apply some of this with a stick to the solder. On touching it then with an iron or steel wire it becomes coppered, and by repeating the experiment the deposit of copper may be made thicker and darker. To give the solder a yellow color, mix one pint of saturated solution of sulphate of zinc, with two of sulphate of copper, apply this to the coppered spot, and rub it with a zinc rod. The color can be still further improved by applying gold powder and polishing. On gold jewelry or colored gold the solder is first coppered as above, then a thin coat of mucilage or isinglass solution is laid on, and bronze powder dusted over it, making a surface which can be polished smooth and brilliant after the gum is dry.

The Hopes of Some Car-Coupler Inventors must have received a rude shock from the reply of the *Railway Review* to inquiries as to which of the *vertical plane* type of car-couplers are favored by the different railroads; whether they are likely to adopt any one in particular; and, if so, what one. To the propounder of these conundrums the journal named replied as follows:

"We would like to satisfy the curiosity of our correspondent, but the information he desires, is, as yet, a profound secret, and in view of the untold wealth which its possession is likely to confer upon its holder, as well as the irreparable injury which its publication would cause to many coupler companies and prospective inventors, we hardly feel justified in making public, at this time, the desired information. Our correspondent will have to possess his soul in patience and wait until a more opportune time arrives for divulging the secret. In the meantime, if he has a coupler of his own, he will probably be happier five years from now if he immediately burns the patterns, models, drawings and sketches, puts the castings in the scrap, and banishes the thing from his mind."

Whetstones made of Arkansas stone were briefly discussed in our October number. It is now stated that a whetstone and oil-stone industry has been started in Denver, the material being taken from Turkey Creek, near Morrison, Colorado. The company quarrying these stones is said to have obtained a quarry of 40 acres of the material. The Denver *News* says that experts pronounce these to be the finest whetstones manufactured in the United States, and that they are equally adapted to be used with oil or water. The stones are said to compare favorably with those imported from Turkey, Germany and Scotland. They are quick in action, and give a smooth edge.

# POPULAR MISCELLANY.

A SYSTEM of Cooling Water in places where water in wells is contaminated by surface drainage to such an extent as to be unhealthful, but wherein the temperature of the water is quite cool, has, it is said, been adopted at Hanover, Pa. Through iron pipes, potable water, brought from a large spring at a distance of about three miles, is conducted into galvanized iron tanks, immersed in the well-water at the bottoms of the wells. From the tanks the water is again conducted through similar pipes to the faucets in the buildings. It is stated, that although the water brought from the spring becomes so warm as to be disagreeable before reaching the wells, after passing through the tanks, it may be drawn at a temperature of 56° F., which renders it very palatable and refreshing. It is easy to see that this principle might be carried out without digging a well, by simply making an excavation to a suffiicient depth below the surface and burying the tank, which is intended to act as a cooler. A difficulty would attend the latter method in some places, owing to the fact that the tank, so buried, would be inaccessible for cleaning.

The Literature of Disinfectants has received a valuable contribution from Mr. C. B. Dudley, Chemist of the Pennsylvania Railroad, and Mr. F. N. Pease, Assistant Chemist, in a series of important papers entitled "Contributions to Practical Railroad Information" now being published in the *Railroad and Engineering Journal*. As may be inferred from the title of this series of papers, the practical side of the character and use of disinfectants, rather than theories of disinfection, form the burden of what these able chemists have written upon the subject, and the following information, derived from their discussion as published, will be of general interest and value to the public at large as well as to railroad managers. It is asserted that the ordinary disinfectants offered upon the market "are so clothed in mystery and high-sounding names, and the prices are so appalling. that most railroad officials shrink from taking any action in regard to them"; and that "what little there is of positive knowledge" relating to disinfectants, "is so little known and understood by the majority of railroad operating officers, at least, to say nothing about the ignorance of the general public, that it is quite natural there should be a good deal of uncertainty and perplexity in the matter." Out of from twenty to twenty-five disinfectants examined by the authors, nine or ten were chiefly carbolic acid; and in twelve or thirteen the active substance was chloride of zinc. Some were mere "mixtures of sulphate of zinc and common salt. One was simply a solution of nitrate of lead." This was six years ago; and none of the disinfectants examined contained any corrosive sublimate. The prices were exorbitant, "and the efficiency of the materials was small." Disinfectants made by the decomposition of turpentine are stated by these writers to be notably good. Chloride of zinc they pronounce to be one of the "most efficient deodorants known." This opinion is based upon results obtained by practical use, the Pennsylvania Railroad Company having used the disinfectant extensively. It is used mixed with terebene, the principal purpose of the latter being as a check upon employés, its pleasant odor serving to indicate that the material has been used as ordered. Other valuable disinfectants are chlorine, hypochlorites, and carbolic acid; but these "are not easily managed in places where people congregate." "Permanganate of potash with bichloride of mercury is extremely valuable." Upon calling for bids for the manufacture of the disinfectant adopted by the road, put up in bottles forty-eight dozen of which contain a barrel of the solution the formula of which is given below, the lowest bid was 14 cents per bottle, including the bottle, and unboxed for shipment. Thereupon the com-

pany proceeded to manufacture the solution at its own laboratory producing the disinfectant at a cost of 5 cents per bottle. Each bottle holds 8 ounces of a solution containing 2400 grains of chloride of zinc, 120 grains of chloride of copper, 10.5 grains of corrosive sublimate, and 10 drops of a mixture of equal parts of terebene and spirits of turpentine. For general use in privies, water-closets, etc., the following directions are given:

"Empty the contents of the bottle into about one quart of water and with sponge or waste, wash with the liquid all parts of the urinal, seat and hopper, and the floor adjacent to them in the closet, allowing some of the liquid to run down the urinal pipe. The same solution should be used on the floors and woodwork. The disinfectant acts slowly on lead, tin, copper, brass, iron, etc., and it is not advisable to allow it to stand in the basins or traps. In the vault, use the disinfectant full strength, not less than half a dozen bottles at once, but it is better to disinfect privy vaults with crushed sulphate of copper, or chloride of lime, sprinkled freely over the mass. For removing bad odors: Empty the contents of the bottle into about one quart of water, and sprinkle the liquid in the place from which the odors arise, also saturate a towel, or other fibrous substance, with the liquid and hang it in the place from which it is desired to remove the odors.

A New Brewery Product is stated by an Austrian paper to be made from maize, and it is also stated that it is manufactured and consumed in constantly increasing quantities in France. The cost of production is said to be much below that of beer made from barley, notwithstanding that the beer itself is in no way inferior to the latter. The new beverage is not the result of any new process, but is made by malting maize, of which it is a pure product, and not (as is done in some districts) the result of mixing maize meal with the worts of barley malt. Owing to the high price of malt, brewers have for a long time been driven to use unmalted cereals for brewing purposes. Experiments have been made with wheat, maize, rice, potato meal, maize syrup, etc. In such cases there was an insufficient development of the saccharine principle, and owing to a lack of soluble nitrogenous matter, fermentation did not proceed satisfactorily. Hence the beer became spoiled by a second fermentation, and, further, there was a lack of albuminous matter and phosphates which constitute the nutritive properties of beer. These defects are all said to be remedied by using maize malt.

An Immense Lumber Contract has been entered into by the Reliance Lumber Company of Beaumont, Texas, which has agreed to deliver to the Omaha, Kansas, Central and Galveston Railroad, connecting Lyons, Kansas, with Galveston, Texas, timber and lumber for bridge-timber, section houses, platforms, stock-pens, etc., amounting to 100,000,000 ft., board measure. It is difficult to appreciate the magnitude of this contract. Reducing board measure to solid measure, it can be easily computed that the timber and lumber contracted to be delivered would make a solid block 40x40 ft. in cross-section, and over a mile long. The cost of the lumber would be about $1,000,000.

The Tendencies of the Age in respect of Trusts is indicated by the organization of a combination of lumber manufacturers in North Carolina to reduce the output and advance the price of lumber. The *Southern Lumberman* states, with reference to this new trust, "that at the present rate of reduction, the pine forest of North Carolina will be destroyed and the manufacturers will have nothing to show for the immense and destructive business they have carried on." The proposed trust is intended to consolidate the individual manufacturers of North Carolina pine lumber into a stock company having a capital of $10,000,000. The paper quoted states that the scheme has been quietly working for several months, having been put on foot early in the summer. At first manufacturers were slow to take hold of the scheme, and the first meeting called to further the organization was very poorly attended. Later in the season Mr. Franklin Knight of Philadelphia, visited the leading manufacturers in behalf of the scheme, and it is stated that he succeeded in inducing a large percentage of the best lumber manufacturers to sign the necessary documents and join the combination. Late in September

circular comprising a list of those who were willing to join the trust was issued. This circular contains the names of a large number of the most influential lumber manufacturers in the State, and indicates that the scheme will be carried out without any further difficulty. The *Atlantic Constitution*, in speaking of this movement, calls it a heroic remedy, and says:

In spite of all that has been written, the destruction of the pine forests of the South goes on at a fearful rate. The lumbermen themselves have realized it, but they seemed powerless to check the enormous waste of this priceless resource. At last the lumbermen of North Carolina have waked up and taken action. It is radical action, of a kind that does not commend itself to the sympathy of the public, but it seems to be the result of a state of affairs almost amounting to desperation. The lumber trade is paralyzed by overproduction, and this best of lumber is going for a price ridiculously low, considering its real value and the prices commanded by the building material of other regions. This action of the lumbermen does not seem to be the right thing. What we should have is a timber-cut restricted by law, and free competition beyond that. It is necessary to restrict the cut to save the forests. Beyond that there is no need of a trust. But if the law-makers won't take hold of the matter and regulate it, the capitalists interested will attempt to regulate it through some such combination as this.

The same state of things with reference to the lumber trade exists in all the States of the great pine belt, and it is likely that the organization of the trust in North Carolina will lead to other similar organizations in States where the lumber interests form the most important industry.

A Sort of Amphibious Velocipede has lately appeared in Marseilles, France, and is described as being simple in its mechanism and equally serviceable upon land and water. Instead of skeleton wheels the wheels are made hollow, so that when the machine enters the water the wheels support it with its rider. The wheels are grooved on their circumference and are provided with rubber tires for land use. At the sides of the wheels are small copper paddles, and when the machine is run from the land into the water these serve to propel it. While the machine can make very good speed on land, it is able to make about three miles an hour in water with the same exertion as is needed for its propulsion on a good road. It does not easily tip over when in the water, and it is stated to have demonstrated its efficiency for rescuing drowning people. It is stated that attention is to be immediately given to the perfecting of this machine. The points in which improvements are desirable are the addition of air-tight compartments, enlargement of the paddles and reduction of the weight of the entire machine. It is thought that by an enlargement of the paddles an increase of 75% over the speed yet attained in the water may be reached.

The Insurance of Buildings against Collapse, which has been suggested since the occurrence of the Park Place disaster, by a number of writers in various papers (among whom is Mr. Edward Atkinson in his article in our present number), has in it some elements of impracticability. The Boston *Commercial Bulletin* points out that the inspection of buildings with reference to their safety against collapse would require to be carried out on an entirely different line from that of ordinary fire-inspection. The collapses of buildings—although when they occur, the circumstances attending them are often of a serious nature—are of comparatively rare occurrence. The journal named argues that the periodical inspection necessary in the system of insurance against collapse, considered in connection with the comparative rarity of such accidents, could only be compensated for by high rates of premiums—in fact, so high as to be prohibitive. It also raises the point that only the proprietors of buildings of doubtful character would seek protection by insurance, and thus the business would be rendered undesirable to insurance companies.

The Connection of Small Villages with existing railway lines by means of short electric railways, when such towns lie at some distance from a main line or from a branch, was suggested and advocated in a recent issue of the New York *Evening Post*. The suggestion is timely and sensible. Such lines may be constructed and operated with so little cost, that a very large

number of towns which cannot be connected with main lines by steam railways, could obtain facilities both for freight and passenger transportation that would meet all their requirements. Doubtless the construction of such roads will be a feature of railroading in the near future, as they are likely to meet with favor both from the out-of-the-way towns and the steam railway companies whose business they would tend to increase, as the short electric railways would become feeders for main lines.

A trihydroxytetrahydrobenzemono-carboxylic acid is what the chemist Mr. J. F. Eykman supposes to be the nature of the new non-poisonous "shikimic" acid found in Illicium religiosum. It is pleasing to reflect that it is not poisonous. After having become nearly demented in the attempt to pronounce the above name, supposed to be chemically characteristic of this new acid, it will also relieve the mind to know that it is a crystalline powder, the crystals being in the form of fine needles soluble in water but insoluble in absolute alcohol, ether, chloroform and benzine. One is almost tempted to ask whether, if under all the transformations chemical technology has undergone it has become burdened with such ponderous terms, its evolution has not demonstrated the falsity of Darwin's doctrine of "the survival of the fittest."

Ice-making by the Use of Natural Gas is called by some of our contemporaries "*a new discovery*." This is a misnomer; the application of natural gas to this purpose might easily have occurred to any one familiar with the action of cold-air ice-machines, in which compressed air which has been cooled to ordinary temperatures is caused to expand while performing work in an engine, and, through the performance of work, loses a portion of its heat. The action is entirely analogous to the cooling of steam expanding in a steam-engine cylinder and exhausting from the engine at a temperature many degrees lower than that at which it is inducted. However, the application, if not a new discovery, is an extremely good scheme. Natural gas is found generally in a highly compressed condition, and as its compression costs nothing, while for all ordinary purposes it is uninjured by expansion, the utilization of the latter for ice-making will be clear gain, if the practical difficulties which will be encountered can be satisfactorily overcome. The chief of these will, we should think, be the condensation and freezing of water during the expansion in the exhaust of the engine; but there are various resources by which this difficulty can be met. As an enormous amount of mechanical power must be stored up in the great reservoirs of natural gas, this power can be utilized not only for the performance of useful work, but the ice product, after the power has been used, can be obtained at no further cost for power; while for lighting, or heating, the gas, being just as valuable as before its use for power and for ice-making, can be delivered into mains for distribution to consumers, precisely as though it had not been so used.

The System of Rapid Transit for New York City is now fixed upon. At the present writing we have yet nothing to go upon except the first reports published in the daily papers (Oct. 20) but these are likely to be nearly correct. The official report of the Rapid Transit Commissioners will doubtless follow very soon. The plan appears to embrace the following features: 1. An underground system of railway—one on each side of Manhattan Island—extending from the battery on the bay to a connecting line beginning at the upper end of the island and running to Yonkers on the Hudson River. 2. An underground cross-town line running under Union Square between Fourteenth and Seventeenth streets. 3. Special tracks for express trains running at the rate of 40 miles per hour. 4. Electricity to be the motive power. 5. The tunnels to be lighted by electricity. 6. Good ventilation of the tunnels. 7. A block system for prevention of accidents. The wisdom of the adoption of electric motive power will be apparent to all who can fully appreciate the requirements for rapid and comfortable travelling on underground railways. The commissioners have performed a very difficult task in a manner that will be warmly commended by all intelligent citizens of New York.

# INDEX TO THE ENGINEERING PRESS.

THE tabulated list contains the names of exchanges most frequently quoted. To save space the abbreviations respectively prefixed are employed in the list of articles following the index. Illustrated articles are indicated by an asterisk (*), continued articles by a dagger (†), and concluded articles by a double dagger (‡). Orders for copies of publications mentioned should be sent direct to the addresses given.

| | |
|---|---|
| A A | American Architect. *m.* 15c. Boston. |
| A E | Architectural Era. *m.* 25c. New York. |
| A & B | Architecture and Building. *w.* 15c. New York. |
| A J R A | American Journal of Railway Appliances. *m.* 25c. New York. |
| A M | American Machinist. *w.* 6c. New York. |
| B J C | Boston Journal of Commerce *w.* 6c. Boston. |
| C A B | Canadian Architect and Builder. *m.* 20c. Montreal. |
| C E | Colliery Engineer. *m.* $2 per year. Scranton, Pa. |
| E E L | Electrical Engineer. *w.* 3d. London. |
| E E N Y | Electrical Engineer. *w.* 10c. New York. |
| E L | Electricity. *w.* 1d. London, Eng. |
| El | Electrician. *w.* 4d. London, Eng. |
| E C | Electricity. *w.* 7c. New York-Chicago. |
| E R L | Electrical Review. *w.* 4d. London, Eng. |
| E R N Y | Electrical Review. *w.* 10c. New York. |
| E W | Electrical World. *w.* $3 per year. New York. |
| E | Engineering. *w.* 6d. London, Eng. |
| E M J | Engineering and Mining Journal. *w.* 10c. New York. |
| E N | Engineering News. *w.* 15c. New York. |
| I L | Industries. *w.* 6d. London, Eng |
| I A | Iron Age. *w.* 10c. New York. |
| I J M S | International Journal of Microscopy and Natural Science. *m.* 6d. London-New York. |
| Inv | Invention. *w.* 6d. London, Eng. |
| J A E S | Journal of the Association of Engineering Societies. *m.* 30c. Chicago. |
| J O I | Journal of Industry. *m.* 20c. San Francisco, Cal. |
| J F I | Journal of the Franklin Institute. *m.* 50c. Philadelphia. |
| J N E W | Journal of the New England Waterworks Association. Quarterly. 75c. New London, Conn. |
| J S A | Journal of the Society of Arts. *w.* 6d. London, Eng. |
| L E | Locomotive Engineer. *m.* $1 per year. New York. |
| P S | Power-Steam. *m.* $1 per year. New York-Chicago. |
| P T | Photographic Times. *w.* 15c. New York. |
| N B | National Builder. *m.* 30c. New York-Chicago-St. Louis. |
| S A S | Scientific American Supplement. *w.* 10c. New York. |
| Sc | Science. *w.* 10c. New York. |
| S | Stone. *m.* 15c. Indianapolis, Ind. |
| R A E J | Railroad and Engineering Journal. *m.* 25c. New York. |
| R G | Railroad Gazette. *w.* $4.20 per year. New York. |
| R M M | Railway Master Mechanic. *m.* $1. Chicago |
| R R | Railway Review. *w.* 10c. New York. |
| W E | Western Electrician. *w.* 10c. Chicago. |

### ARCHITECTURE.

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Different Methods of Dying Wool. Max Breiter. (Manufacturers' Review *m.* $2 per year Oct.)

Dying Uniform Colors. Jules Garçon (Ibid.)

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A Gem Bearing Granite Vein in Western Connecticut. L. P. Gratacap (S A S–Oct 3.)

Early Discoveries of Coal in the United States. (Progressive Age *w* $3.00 per year–Oct 15.)

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### MINING.

The Lidgerwood Suspension Cable-Way and the Edison Ore-Concentrating Works at the Ogden Mines, N. J.* (E M J–Oct 10.)

The Principles and Practice of Coal Mining on the Pillar Systems.* W. S. Gresley, M. E. (C E–Oct.)

Coal Mining in the Belleville Seam No. 6, St. Clair Co., Ill.* Leo Gluck, E. M. Colliery (C E–Oct.)

Notes on Electrical Work in Mines. Albion T. Snell (C E–Oct.)

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### PHOTOGRAPHY.

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Photography in the Tropics. S. W. Burnham and J. H. Schaeberle (P T–Oct 2.)

Jove's Autograph on a Photographic Plate. W. N. Jennings (E C–Sept 30.)

### PHYSICS.

The Velocity of Light Regarded as the Velocity of Matter. F. Tolver Preston. (The Electrician *w.* 4d. London–Sept 25.)

On an Electrical Method of Determining the Mechanical Equivalent of Heat. M. D. Arsonval (Ibid.)

Celestial Physics. William Huggins (Sc–Oct 16.)

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Economical Working of a Small Gas Works. F. Weller (Progressive Age *w.* $3 New York–Oct 15.)

The Efficiency of Washers in the Extraction of Ammonia. Dr. Bueb, Chemist (Ibid.)

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The National Transportation Association—Proposed Uniform Bill of Lading (R R–Oct 3.)

How Scalping May Be Prevented. P. S. Eustis (R R–Oct 10.)

The Interstate Commerce Commission and its Work. Hon. Augustus Schoonmaker (R G–Oct 16.)

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The Baird Evaporator. * (Army and Navy Journal *w.* 15c. New York–Sept 26.)

Steam Boilers for Electrical Installation. W. H. Booth and Frank B. Lea (E R L–Sept 8.)

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The Ammonia Steam Engine (E M J–Oct 17.)

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Notes on Combustion. C. Chomieme (R E J–Oct.)

The Steam Engine Indicator (P S–Oct.)

Steam Boiler Experiments of M. B. Donkin Jr. and Professor Kennedy (E–Oct 2.)

**MISCELLANEOUS.**

Artificial Rainmaking. Prof. Edwin J. Houston (J F I–Oct.)

Long Staple Cotton (B J C–Oct 10.)

Critical Review of Efficiency Tests of Coal.† William Kent, M. E. (E M J–Oct 10.)

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Piece-Work. W. H. Booth (A M–Oct 8.)

On the Cultivation of the Inventive Capacity by the Solution of Constructive Problems.* Leicester Allen (A M–Oct 8.)

Mechanical Flight. William H. Harrison (A M–Oct 8.)

Report of the Board Appointed by the Navy Department to Examine into and Report upon the Stagnation of Officers in the Line of the Navy, and Recommend Measures to Regulate Promotion and Increased Efficiency of the U. S. Navy (Army and Navy Journal, *w.* 15c. New York–Oct 3.)

Gas Supply in the Hands of Local Authorities. Richard J. Hepworth (Progressive Age, *w.* $3.00 per year–Oct 1.)

The Use of Compressed Air in Conjunction with Medicinal Solutions in the Treatment of Nervous and Mental Affections. J. Leonard Corning, A. M., M.D. (S A S–Oct 3.)

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The Trades Union Congress (E–Sept 18.)

The Evolution of Algebra. E. W. Hyde Sc–Oct 2.)

The Evolution of the Cerebellum. C. L. Herrick (Sc–Oct 2.)

The Tin-plate Outlook (I A–Oct 16.)

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Rainmakers in the United States* (S A S–Oct 17.)

The Distillation of Molasses. Charles Debremond (S A S–Oct 17.)

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Progress in Flying Machines.* O. Chanute, C. E. (R E J–Oct.)

English Electrical Exhibitors at the World's Fair (E C–Sept 23.)

Avalanches in Austria and and Switzerland (R G–Sept 25.)

Practical Stone-Cutting. D. F. Kennedy (S–Oct.)

# A WORD OF INTRODUCTION.

EDWARD ATKINSON, of Boston, the distinguished economist and statistician who writes in this number on the "*Lessons of the Park Place Disaster*," has contributed largely not only to the literature of fire-proof construction, but also to the solving of practical problems in actual building operations.

ANDREW CARNEGIE, the Pittsburgh iron-master and the distinguished author of "Triumphant Democracy," writes on "*An American View of British Federation*," a subject on which he doubtless is as well qualified to express opinions of weight as any other Anglo-American citizen.

JOSEPH KENDALL FREITAG, who writes of "*The World's Fair Buildings*," is the Assistant Engineer of the World's Columbian Exposition, and has sustained such a relation to the work in progress in Chicago, from the beginning, as to qualify him to write authoritatively on the subject.

C. J. NORWOOD, of Frankfort, has been for years the State Inspector of Mines for Kentucky, a position which has made him familiar with the "*Perils of Coal-Mining*," on which he writes in this issue.

ALBERT WILLIAMS, JR., who discusses the question "*Has the Limit Been Reached in Armored War-ships?*" is a mining engineer of distinguished attainments, who is also known as a writer on engineering topics generally. He is now resident in Denver, Col.

JOHN A. CHURCH, of New York, is a mining engineer of wide experience, one chapter in whose work is detailed in the paper entitled "*Silver Mining Among the Chinese*."

GEORGE W. RAFTER, the author of the paper on "*The Equipment of Pumping Stations*," is a civil engineer who has made a specialty of the construction of municipal waterworks, having designed such works in many parts of the United States. His residence is in Rochester, N. Y.

GEORGE R. DUNELL, of Chiswick, England, who will describe "*The Great Manchester Ship Canal*," has a professional relationship with the engineers in charge of that great undertaking which fits him particularly for treating of the practical problems involved.

BARR FERREE, an architect of distinction, is a member of the faculty of the University of Pennsylvania, being connected with the School of Architecture of that institution. His residence at present is in New York. He writes of "*Museum Building and Arrangement*."

EDWARD HENRY, who takes the conservative side of the very interesting discussion as to "*What is the use of Building Laws?*" is an architect by profession, a former resident of Philadelphia, and a gentleman of very liberal education and wide reading. He is in every way most admirably equipped to present his chosen side of the issue.

JOHN BEVERLEY ROBINSON, who takes the radical position of opposition to all building legislation, is an active practising architect of New York, and one whose experience in contact with the intricacies of the New York building law prompted the very striking contribution to our August number which excited the present controversy.

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Special articles upon subjects of practical importance and current public interest are invited from experts in all branches of the engineering, architectural and mechanical professions, and, if available, payment for same will be made at liberal rates. The length of leading articles is limited to an average of about three thousand words each, and contributors are specially requested to avoid, as far as possible, the use of terms and formulæ that are essentially technical. The magazine is founded upon the idea of treating only the principles involved in engineering problems—which are always simple—to the end that our circle of readers may embrace, in addition to professional men, the thousands of intelligent business men who are interested or actively engaged in the industrial enterprises of our times, but who are without technical training. When accompanied by proper postage, manuscripts will be returned if not available.

With our forthcoming December number, a department entitled "Comment and Criticism" will be established, as a medium for the expression of individual criticism of what appears in our own pages or elsewhere. Contributions to this department are cordially invited, as it is one of the means by which we hope to attain the highest standard of excellence in reflecting through our pages the latest and best practice in every branch of modern engineering. No attention will be given to anonymous communications.

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All communications upon editorial subjects should be addressed to the Managing Editor, and correspondence in relation to business matters should be addressed to the Company.

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